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1936 • 1937

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IRON AND STEEL ENGINEER

VOL. XIV DECEMBER • 1937 NO. XII

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Material saved by wasteless cutting—cleaning at amazing speed and saving remelting costs and losses.	**THE FACTS**	Time-tried it has proved it will yield amazing returns.

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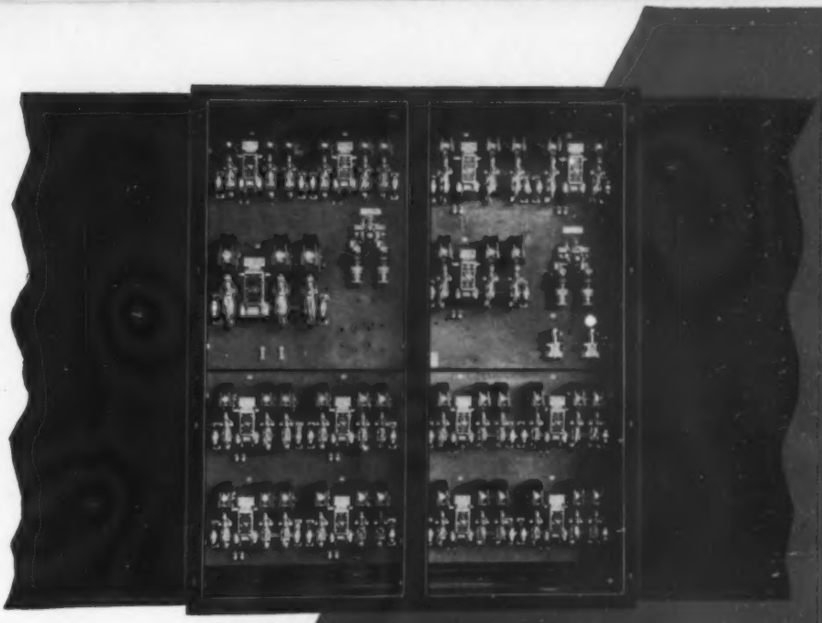
STEEL EQUIPMENT DIVISION

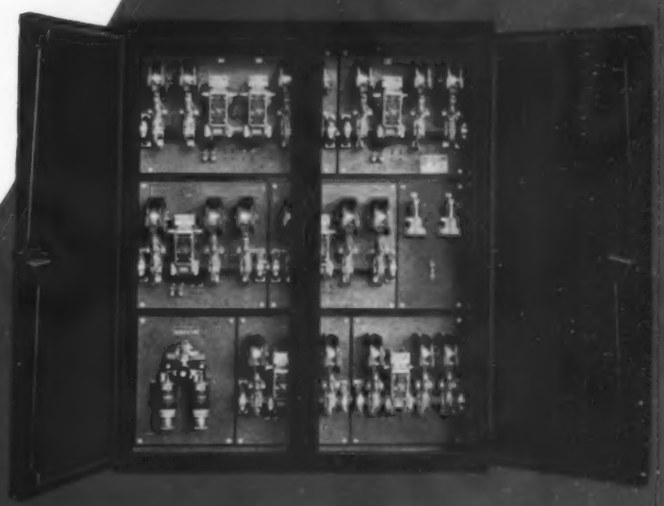
CANTON • OHIO

The purchaser of this BILLETEER specified EC&M LINE-ARC Magnetic Contactor Control



Controller for separate mounting which operates carriage-drive, approach and run-out tables, etc.

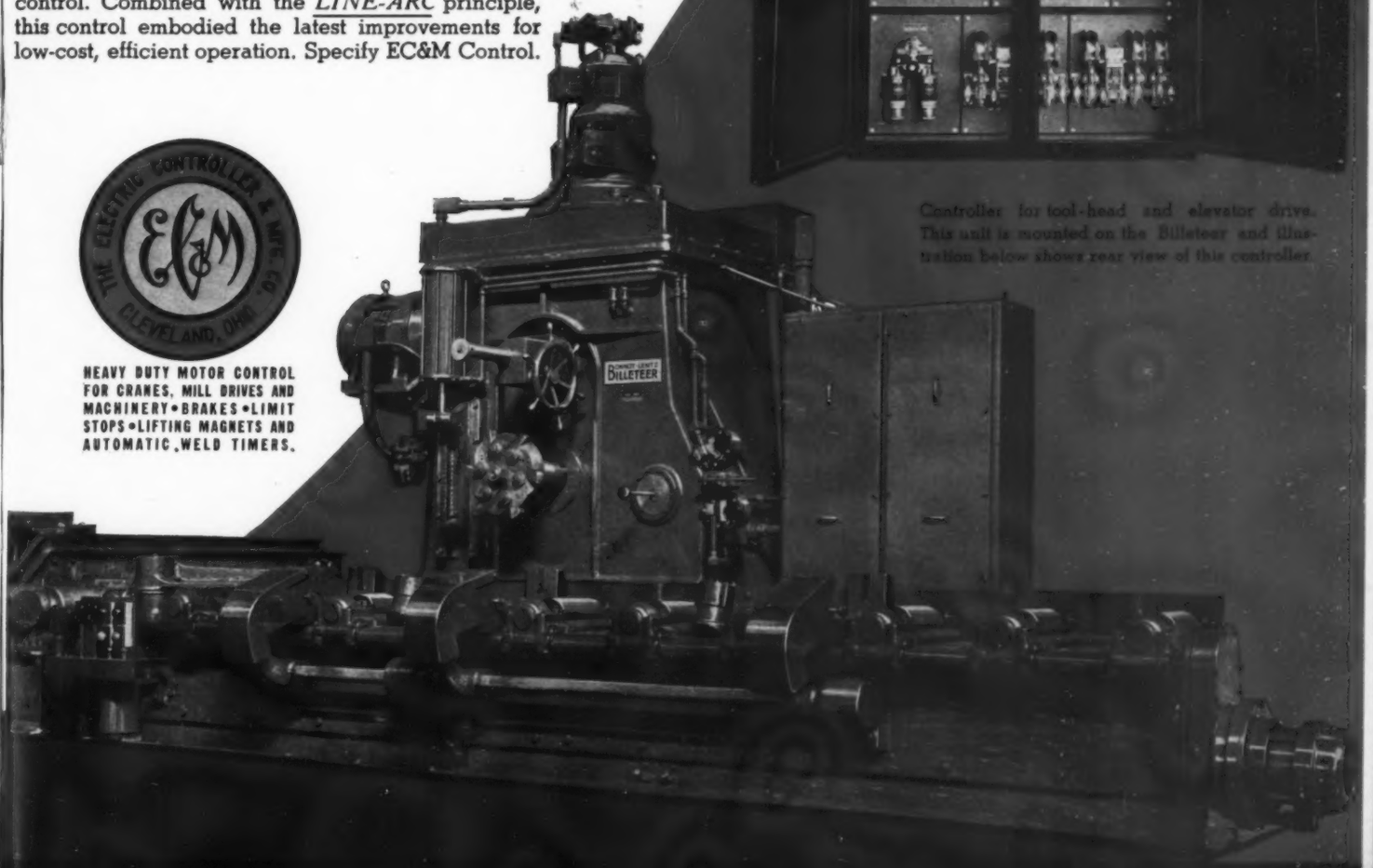
IN KEEPING with the modern trend of selecting latest-design equipment, the purchaser of this Billeteer selected EC&M *LINE-ARC* Magnetic Contactor Control. They knew that this EC&M Control was exceptionally fast in operation and that the new method of handling the arc, embodied in this control, meant longer life of contacts and elimination of destructive burning on the arc shields. From examination of the control, they learned that oil-ite, self-lubricating bearings, new cable-type shunt connectors and similar features, meant practically trouble-free operation throughout the life of the control. Combined with the *LINE-ARC* principle, this control embodied the latest improvements for low-cost, efficient operation. Specify EC&M Control.



Controller for tool-head and elevator drive. This unit is mounted on the Billeteer and illustration below shows rear view of this controller.

THE ELECTRIC CONTROLLER & MFG. CO. E&M CLEVELAND, OHIO

HEAVY DUTY MOTOR CONTROL FOR CRANES, MILL DRIVES AND MACHINERY • BRAKES • LIMIT STOPS • LIFTING MAGNETS AND AUTOMATIC WELD TIMERS.



CONTROL BY EC&M

FORD ENGINEERS

INSTALL 12 MORE BELL TYPE

WESTINGHOUSE FURNACES

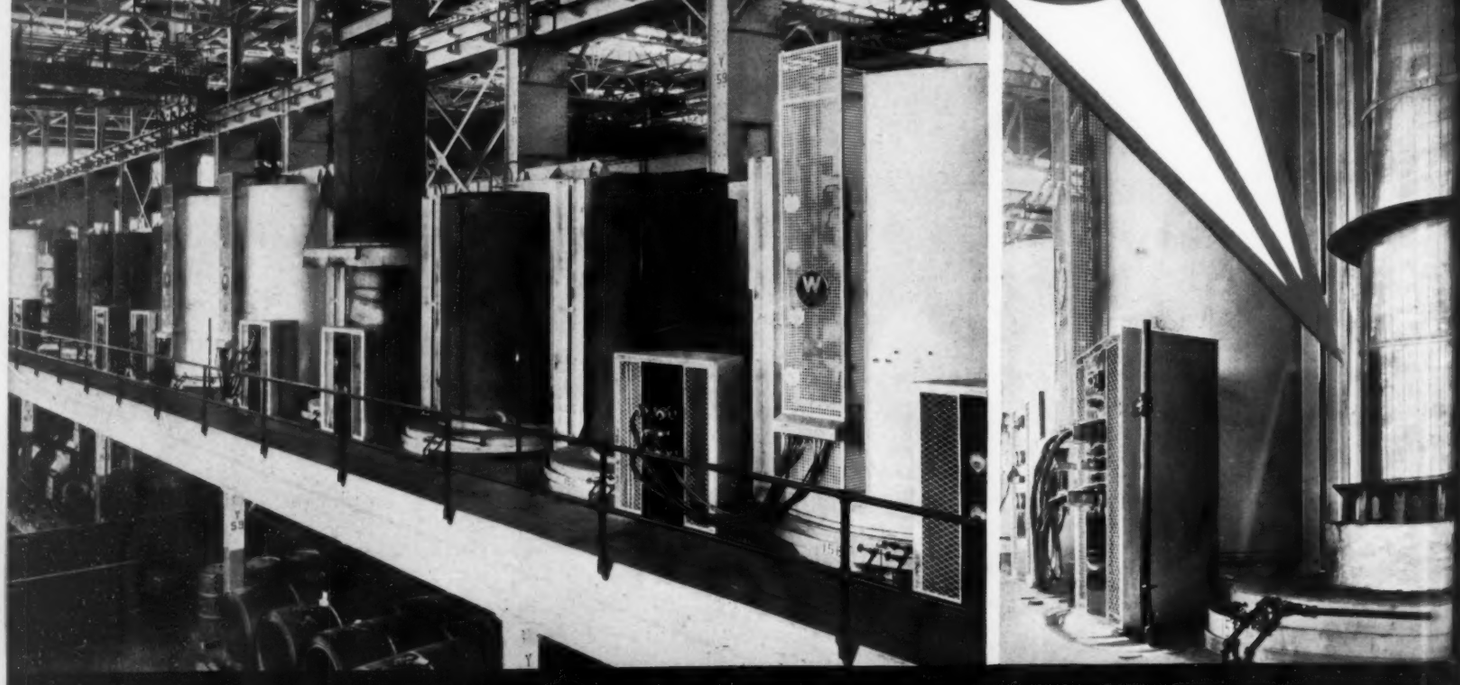
AT RIVER ROUGE, MICH.

The exacting requirements of Ford engineers when they buy equipment are well known.

That they purchased 12 additional Westinghouse bell-type furnaces for annealing low-carbon strip steel (for automobile bodies) is convincing evidence of the efficient operation and satisfactory service of the 12 Westinghouse furnaces installed in 1935.

When these new units are installed, 24 of the 37 bell-type furnaces operating at River Rouge will be Westinghouse.

J 11048



View showing Westinghouse cylindrical bell-type annealing furnaces installed in the Ford Steel Mill at River Rouge, Michigan.

Westinghouse

EDITORIALS

EDUCATIONAL PROJECTS

For sometime the Board of Directors of the Association of Iron and Steel Engineers have had under consideration the question of applying some of the surplus funds of the Association to an educational project.

At a recent meeting of the Board, a suggestion was made that each district be permitted to work out this educational problem by being granted a yearly allotment for the experiment of their idea in their district section.

The various plans discussed by the Board were as follows:

Proposition No. 1

Two, possibly three scholarships for a period of a year, the course selected by the student to relate preferably to some engineering activity of the Steel Industry.

Proposition No. 2

The furthering of some kind of research work by an institution similar to the Mellon Institute of Pittsburgh, preferably on a subject related to steel mill improvements.

Proposition No. 3

Making a contribution to establish a chair of education to further the facilities of a college in reference to a course pertaining to some branch of steel mill engineering.

Authorization has been given to the various district sections, namely, Philadelphia, Cleveland, Chicago, Pittsburgh and Birmingham, to proceed with a development of a plan in line with the above suggestions and as soon as such a plan has been worked out the members of each section will be advised accordingly by the local committee.

It is thought that by the experience gained a definite decision can be made regarding a general educational plan to be carried out by the Association.

AMERICAN STANDARDS ASSOCIATION

The American Standards Association, 29 West Thirty-Ninth Street, New York, is the national body representing Industrial Standardization. The Member-Bodies consist of the principal engineering associations, industrial associations, machinery manufacturers and several departments of the Government. The Associate Members consist principally of the smaller engineering and industrial societies and machinery manufacturers.

The Association of Iron and Steel Engineers were invited to take out membership in the American Standards Association several months ago. After carefully considering this invitation the Board of Directors have authorized that an Associate Membership be applied for. We have recently been advised of our election as an Associate Member of the American Standards Association.

As an Associate Member the Association will receive all material circulated to Member-Bodies, and meetings of the Standards Council are open to our representatives and are thus enabled to keep in close touch with all phases of the work as it develops.

Services to Associate Members include:

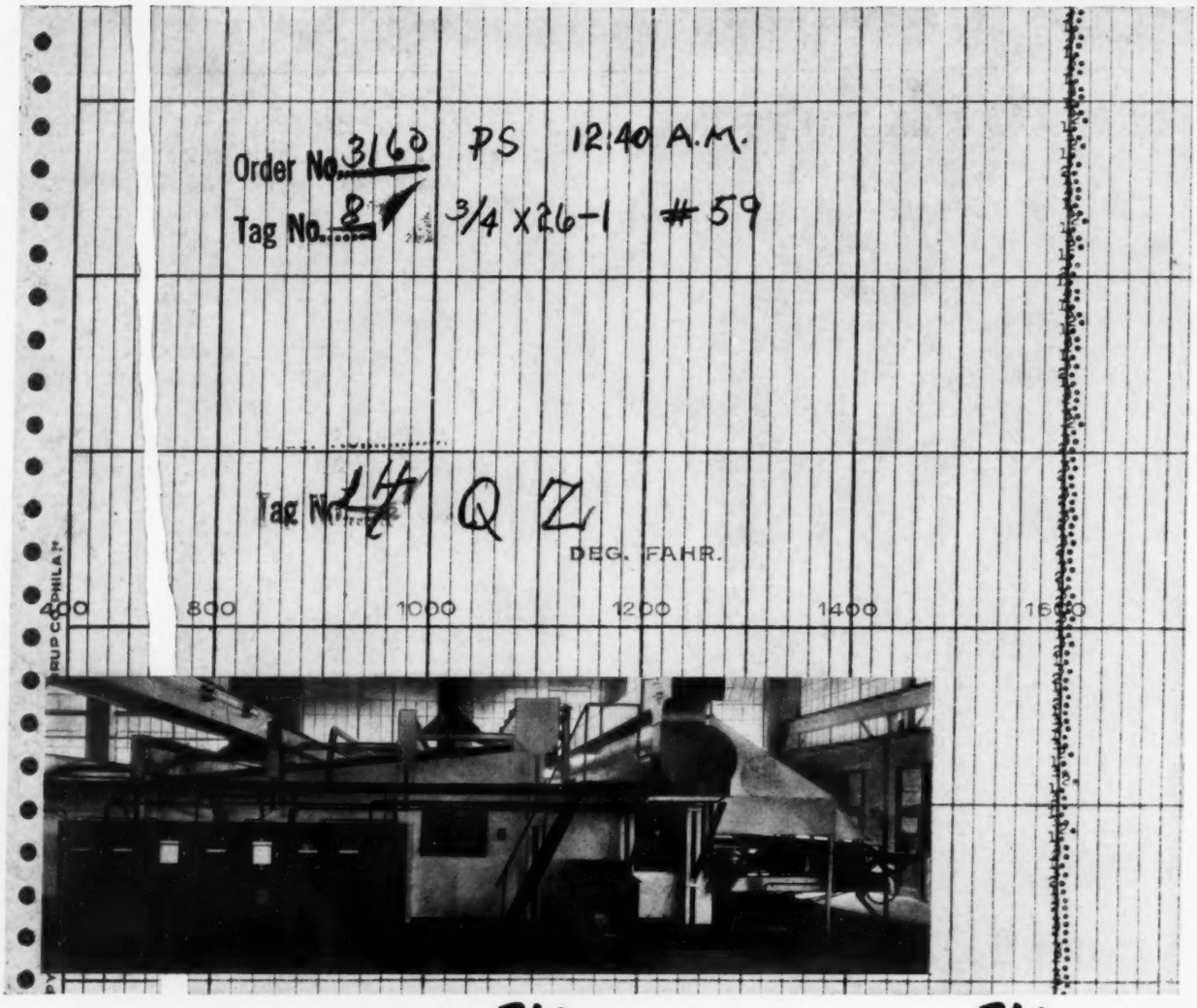
1. Copies of all material sent to Member-Bodies (with the exception of letter ballots.) This material enables the Associate Member to check in at the start and follow the procedure of all projects.
2. Six subscriptions to INDUSTRIAL STANDARDIZATION, a monthly publication of the ASA, which will afford constant touch with standardization activities both here and abroad.
3. One free copy of each new American Standard upon publication.
4. Free use of the ASA library of 20,000 American and foreign standards, specifications and related publications. This collection is probably the most complete in America. Any of this material may be borrowed and most of it is available for purchase.
5. General information service on Standardization work.

Our Association has been cooperating for a number of years in the work of two of the technical committees—the National Electrical Safety Code with a committee which is now being reorganized and the Safety Code for the Protection of the Heads and Eyes of Industrial Workers which is now undergoing revision.

The chief purpose of the American Standards Association is to bring together the manufacturers, distributors, consumers, technical specialists, etc., directly concerned with any particular standardization project and any responsible organization may request the initiation of a project under ASA procedure.

Undoubtedly the cooperation of the member-bodies with the ASA will be of material assistance in carrying out any standardization program which the Association may consider advisable.

While as an Associate Member our Association will receive only a limited number of copies of news standards we will have available at the headquarters full information regarding the Standards listed and will advise our members from time to time regarding new Standards that are issued.



IN BIG FURNACES LIKE *This*.. GET UNIFORMITY LIKE *This*.. WITH

MICROMAX ELECTRIC CONTROL

Here's a 64-burner gas-fired furnace, more than forty feet square *inside*—for continuous normalizing of "sucker rods." Yet, big as it is, it's so precisely regulated by Micromax Electric Controls that couples located at points of greatest temperature departure always stay within ± 10 degrees, and generally within half that limit. Its owner, the Axelson Mfg. Co., St. Louis, reports "no difficulty whatever" in holding these temperature limits.

For all its effectiveness, Micromax Electric Control is so simple, so sensitive and so correct in operating principle, that one of the identical Micromax Pyrometer and Drive Unit combinations on this furnace could be used "as is"—without the removal or addition of a single part—on a tiny oven furnace, a pot furnace, still or practically any other heat-using equipment. You can standardize on Micromax Electric Control for every furnace. You can have big-furnace dependability of control for the small units; small-furnace simplicity for the big ones.

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MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

J-NA(7)

WHAT'S AHEAD FOR 1938?

STEEL FACES TO

It is a tomorrow as unlike today as today is unlike yesterday. There will be new conditions to face; new problems to solve. All about us we see the signs; towering costs, decreasing profits.

To help Steel meet tomorrow's conditions is the ambition of the **greater** Blaw-Knox that today represents a combination of the facilities, talent, experience, knowledge and man-power of a number of highly specialized factors in the steel industry.

Each of these companies holds a salient position with relation to steel as well as to other industries, each is well-known and highly regarded. Together—working in various ways toward the same end—they constitute a service so far-reaching, so genuinely helpful, so productive of greater profits, that Blaw-Knox has earned the title—Steel's Partner.

Above everything, Blaw-Knox is steel-minded. Steel operators and Blaw-Knox talk the same language, wrestle the same problems, pull in the same direction. Blaw-Knox research facilities—greatly expanded—are continually reaching into unexplored territory to find short cuts, methods of economy, more efficient equipment, new ways to help Steel meet the conditions which are imposed upon the industry.

All this experience is available for the asking. Blaw-Knox engineers are at your service whenever you wish and without obligation.

BLAW-KNOX
Steel's Partner

DIVISIONS OF BLAW-KNOX COMPANY: Blaw-Knox Division • Lewis Foundry & Machine • National Alloy Steel • Pittsburg Rolls • Union Steel Castings • Power Piping Division • Gord Lubricators • Blaw-Knox Sprinkler Division

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TOMORROW

BLAW-KNOX

Service to Steel

PARTIAL LIST OF PRODUCTS

BLAW-KNOX DIVISION
OF BLAW-KNOX COMPANY

Water cooled doors and frames, valves, ports, slag line coolers, bulkhead coolers, burner coolers, mantel coolers, buckstays, preheaters, dolomite machines, sloping backwalls, Venturi furnaces, single motor door hoists, annealing boxes, covers and pots, galvanizing kettles, etc., clamshell buckets, steel grating and treads, standard buildings, steam purifiers, gas cleaners, etc.

LEWIS FOUNDRY & MACHINE
A DIVISION OF BLAW-KNOX COMPANY

Chilled iron and iron alloy rolls for iron, steel, brass, copper, aluminum, zinc and nickel, hot sheets, cold sheets, tin plate and strip, merchant bars and rods, special machinery for the rolling mill industry.

Mill drives, three high mills, continuous bar and billet mills, cold mills for sheet and strip, shape straightener machines, motor operated screwdown for mills, gear sets, plate levelers, rail breakers, rail re-rolling mills, universal mill spindles, shears of all varieties, testing machines.

UNION STEEL CASTINGS
A DIVISION OF BLAW-KNOX COMPANY

Spindles, coupling boxes and other steel mill castings of UNIVAN "C" to insure great strength and exceptional wearing qualities. Charging boxes made of tough UNIVAN alloy have longer life because of unusually high impact value.

PITTSBURGH ROLLS
A DIVISION OF BLAW-KNOX COMPANY

PHOENIX ROLLS: Phoenix steel for unusual strength, Phoenix "A" (steel alloy) for strength and wear; Phoenix metal—Phoenix "K" for strength, wear, and finish, Phoenixloy (uniformly hard) for flat rolling where high finish of extremely thin gage of material is required to be free from all marks and defects; also tube mill rolls of quality material best suited to the kind of service required. Phoenix Chill—Phoenix nickel chill for all flat rolling requiring finish.

NATIONAL ALLOY STEEL
A DIVISION OF BLAW-KNOX COMPANY

Special alloy castings for service under severe conditions, creating savings in operations especially with regard to problems involving high temperature, corrosion and abrasion.

POWER PIPING DIVISION
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Pipe systems prefabricated and erected. Prefabrication guarantees greater dimensional accuracies of sub-assemblies, few field joints to be tested, freedom from shutdown due to failure.

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OF BLAW-KNOX COMPANY

Automatic sprinkler systems guaranteed to meet all insurance requirements.

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Grease lubricating systems for heavy machinery. Automatic and mechanical control.

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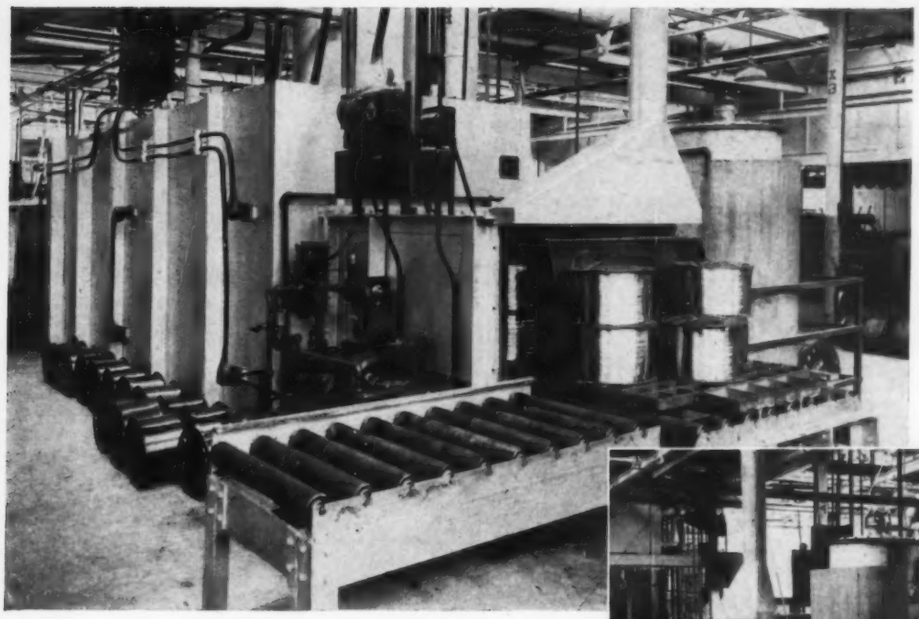
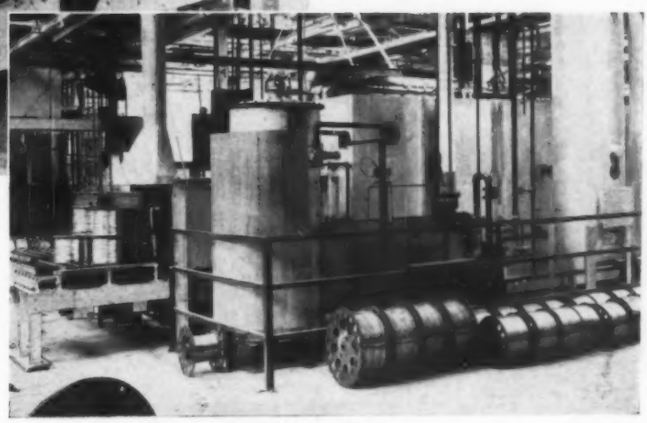




Special Atmosphere

Continuous Furnaces for

Bright Annealing Wire

Uniformly, Economically and Continuously

Wire from the finest gauges to the heaviest sizes is bright annealed uniformly, economically and continuously in special atmosphere furnaces of the type shown above.

Coiled wire, as well as wire on small spools and large reels, is successfully handled in this equipment. No water seals or vapor of any kind is used, thus staining is entirely eliminated and no drying necessary. The wire is discharged from the furnace uniformly annealed, absolutely bright and dry, ready for shipping, further processing or fabricating. The above is one of several types of electric and fuel-fired furnaces we have developed and built for bright annealing ferrous and non-ferrous wire.

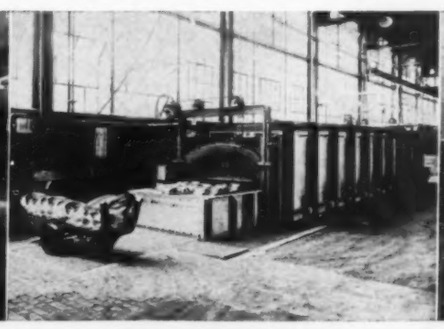
Other recent installations include furnaces for bright and clean annealing brass and copper wire, improved pit type furnaces for normalizing rod and bright annealing steel wire in coils, as well as furnaces for scale-free hardening bolts, springs, etc., billet heating, bright annealing tubing, strip, stampings; carburizing, copper brazing and other heating and heat treating processes.

If you are interested in improving the quality of your anneal or heat treatment, increasing production or are contemplating any changes or additions to your furnace equipment, our engineers will be glad to work with you. We specialize on building production furnaces to fit the customer's specific requirements — for any heating process — for any product or production.

The Electric Furnace Co., Salem, Ohio

Gas Fired, Oil Fired, and Electric Furnaces—Designed to Fit any Requirement

Gas-fired pits for bright annealing wire and normalizing rod.



Continuous conveyor type, gas-fired furnace annealing wire in coils.

Electrically heated pit type furnace for annealing special alloy wire.

Put Your LIGHTS on WHEELS

with BULL DOG UNIVERSAL TYPE

Trol-E-Duct

With BULL DOG Trol-E-Duct Your Lighting Can Be Readily Adapted to Both Your Building Structure and Your Equipment or Machinery Layout—

Underneath view of DUCT in which Busbars are mounted and into which TROLLEYS are inserted.

The movable, current carrying TROLLEY

Cross Sectional View, Showing Rolling TROLLEY Inserted In DUCT.

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Lighting Fixture attached to a TROLLEY which acts as both feeder and movable means . . . Any type of Lighting Fixture can be adapted for use with TROL-E-DUCT.

Write for Illustrated Bulletin

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Pioneers of Flexible Electrical Distribution Systems

DETROIT, MICHIGAN

BULL DOG ELECTRIC PRODUCTS OF CANADA, LTD., TORONTO, ONT.

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5 REASONS WHY SUPEREX BLOCKS

assure maximum economy in steel-mill operation

1 SAFE AT HIGH TEMPERATURES

Made of selected and calcined diatomaceous silica, blended and bonded with asbestos fiber, Superex has unusual heat resistance. Safe at 1900° F. and it stands up under the severest service.

2 HIGH INSULATING EFFICIENCY—LESS THICKNESS REQUIRED

Because of its low thermal conductivity, for the same insulating value, a lesser thickness of Superex is required than any material of equal heat resistance.

3 PICK YOUR THICKNESS

Superex is furnished not only in the thicknesses shown above, but also in any intermediate thickness desired. No waste; you buy only the thickness you need.

4 LOW INSTALLATION COST

Blocks are large (up to 12"x36"); they are light (23 lb. per cu. ft.). Superex goes on quickly, economically—as much as 3 sq. ft. at a time—with marked savings in labor cost.

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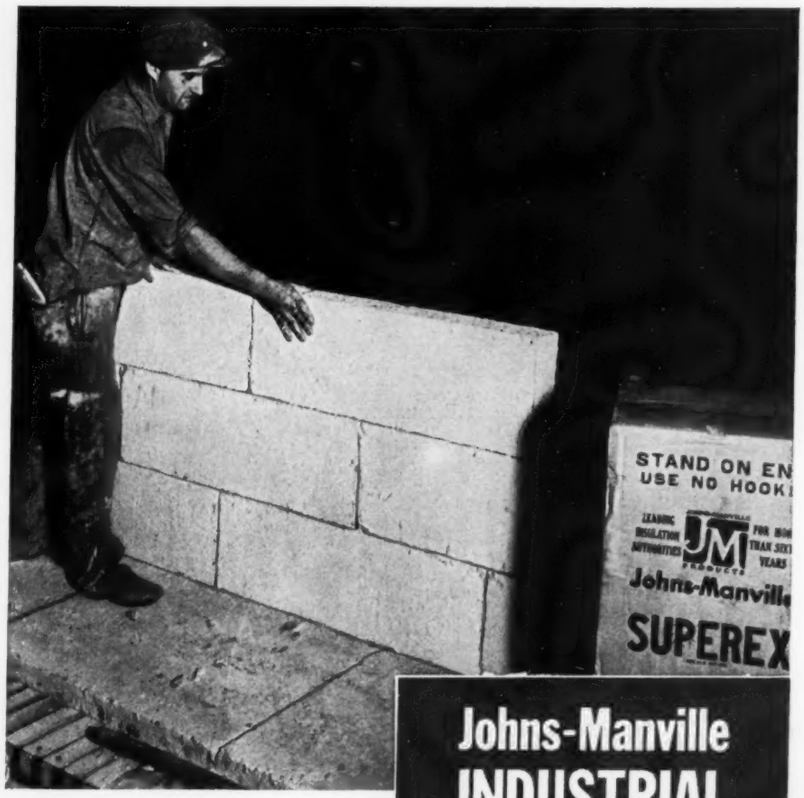
Whatever insulation you use, however carefully you apply it, there will be heat leakage through joints. But because of Superex's large-size units, such losses are reduced to a negligible degree.



HERE, briefly, are five important reasons why J-M Superex assures trouble-free service . . . maximum economy and efficiency in the insulation of slab-heating, annealing and all types of controlled-atmosphere furnaces, producer-gas mains, hot-blast stoves, open hearths and regenerators, and soaking pits.

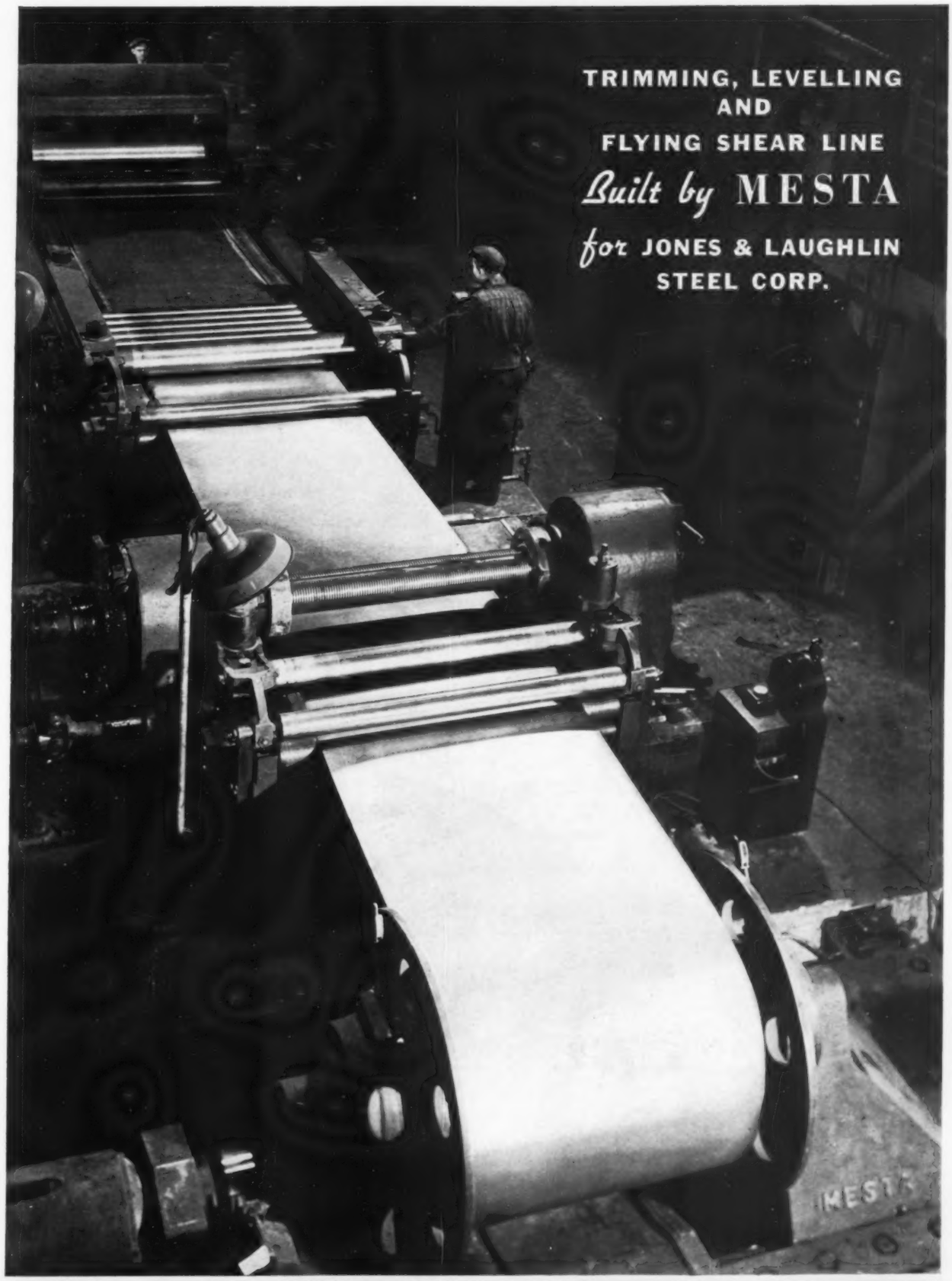
And as a result . . . for many years, in many thousands of installations, Superex has proved itself the outstanding block insulation for high-temperature equipment.

Perhaps you have modernization plans or the installation of new equipment in mind. If so, you, too, can assure maximum efficiency and operating economy, unfailing service under the severest conditions, by specifying J-M Superex Blocks. For complete information on Superex, Sil-O-Cel and JM-20 Brick and other J-M Insulations for the steel industry, write Johns-Manville, 22 East 40th St., New York City.

Johns-Manville
INDUSTRIAL INSULATIONS

JM PRODUCTS

For every temperature condition from 400° F. below zero to 3000° F. above



MESTA MACHINE COMPANY, PITTSBURGH, PA.

T. E. HUGHES

ORGANIZATION and FUN MAI

By T. E. HUGHES, Chief Maintenance Engineer

J. J. BOOTH, Assistant Chief Maintenance Engineer

Carnegie-Illinois Steel Corporation

DUQUESNE, PENNA.

▲ THE term, Maintenance Department, is of comparatively recent origin in the steel industry. It combines the functions of the service departments formerly known as the electrical and mechanical departments. In some plants, other service departments are included in the combination.

In the early steel mills, the fore-runner of the steel mills of today, there was the mechanical department, which had charge of practically all installation and maintenance of equipment. The reason for this was that all of the equipment was mechanically driven by steam engines.

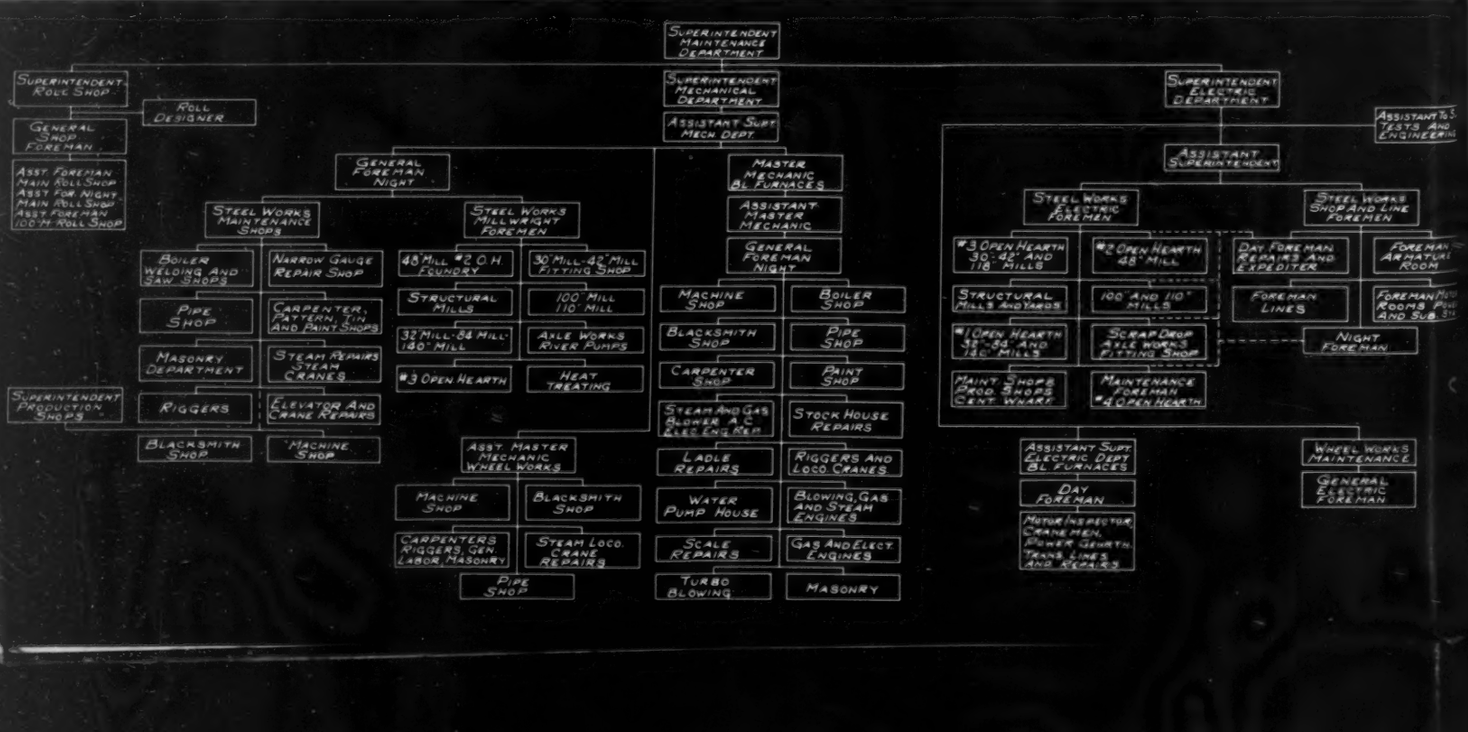
Then there appeared in the steel mills, a new type of equipment known as the arc light generator, and after these machines came the electrical motor applied to overhead cranes, small hoisting machines, and motors driving lineshafts for machine tools. From this period on, there was a gradual increase in the use of electricity in the steel mills, comprising lights, auxiliary drive motors and electrical control. During the period from 1915 up to the present date, the application of motor drives for mills and auxiliaries has advanced to a point where the electrical department of the steel plant is now one of the major service departments.

During these many years, covering the development of the iron and steel industry, there has been a steady improvement in mill equipment design.

Cast gears gave way to improved cut gears and the old style bearings which would not hold oil or grease gave way to sealed sleeve bearings or anti-friction bearings. Belt driven group drives were superseded by individual drives or gear reduction drives. The old type mill housings with brass, bronze or babbitt bearings were replaced by the modern housing equipped with roller bearings or other types of modern bearings, completely assembled as units ready for installation by overhead cranes.

Mill tables and finishing tables are designed today so that little maintenance is required as compared to the old days.

FIGURE 1



FUNCTIONS of a MAINTENANCE DEPARTMENT

Presented before the A. I. & S. E. Annual Convention, Chicago, Illinois, September 28, 29, 30, October 1, 1937

J. J. BOOTH

The electrical and mechanical departments have kept in step with modern improvements, and with the demands placed on manufacturers today by the purchasers of their product.

For many years in the steel business, the mechanical and electrical departments were considered as necessary evils to be endured to keep the mill wheels turning, but having little to do with the practical production of steel, or, in other words, just expense departments. Today, the maintenance department plays an important part in the production of steel, and it is now recognized that the service departments are in the classification of major saving departments.

The maintenance department is a department organized by combining the necessary service departments for the purpose of keeping production equipment in efficient operating condition. To be a true service department, it is essential that the maintenance group support a strict program of maintenance prevention, which requires a schedule of routine inspection for the purpose of detecting minor faults and correcting them before they reach the stage of major breakdowns. The division should also carry on a development study for the purpose of improving existing equipment, working on the premise that replacements in kind will not be made unless the development study indicates no better substitute is available.

The success of a maintenance department is dependent largely on its personnel. The size of the steel plant, or the number of men employed in the combined service groups, is not as important as the organization.

The success of a maintenance department lies in the corodination of the functions of the auxiliary or service departments into a department having as its purpose the supplying of efficient service. Centralized responsibility is conducive to efficient service.

There are several methods of organization which may be used in establishing a maintenance department:

The present-day maintenance department comprises in the main the old mechanical and electrical departments. To these may be added additional departments, such as masonry, foundry, transportation, roll shops and production shops, depending on physical layout and location of plant.

Having outlined the divisions making up the maintenance department, the first charts should be charts showing the functional organization.

The functional organization having been established, the next step is to determine the methods of handling shop work, field work and general maintenance in divisional groups such as blast furnaces, open hearths, blooming mills, finishing mills, etc.

The detailed methods of execution of the work may take on one of several forms. For instance, all shop

FIGURE 2

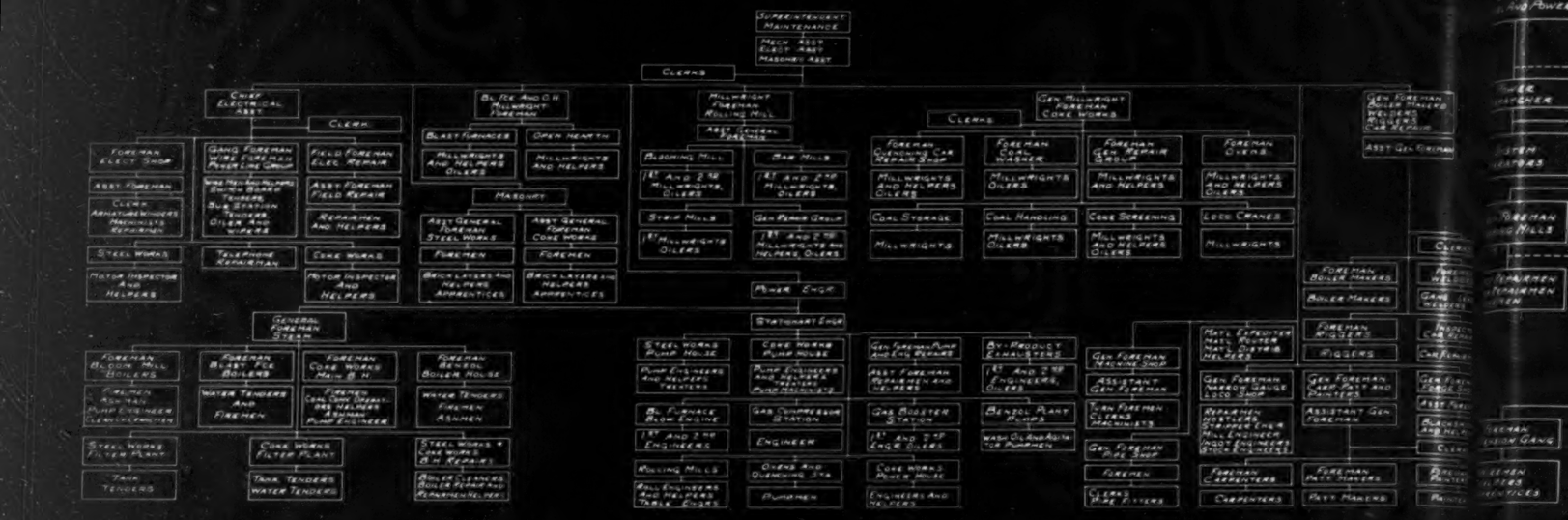


FIGURE 3

and field work may be either centralized in one group with centralized supervision, or decentralized into as many groups as the producing divisions demand, with centralized supervision. In general, depending on physical layout of plant, and local conditions, centralized shop and centralized field work seem to lend to the most economical and efficient organization.

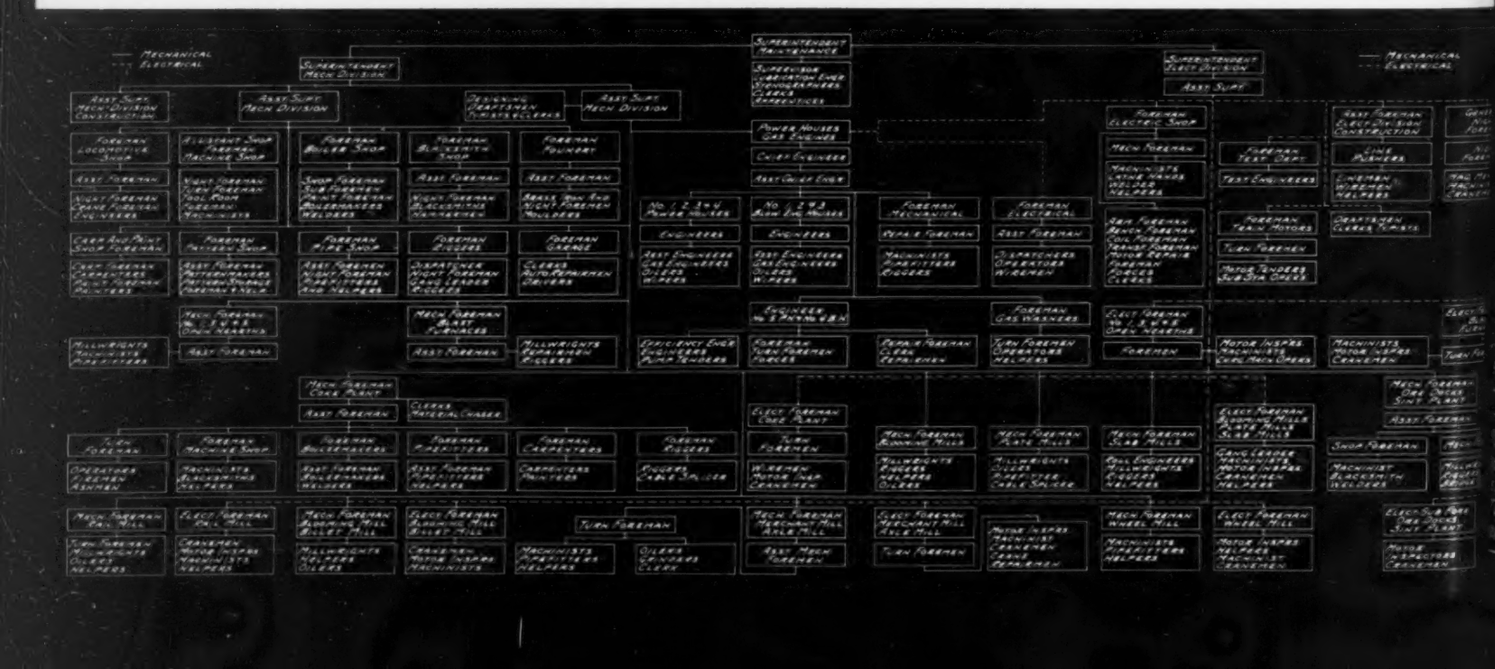
Figures 1 to 4 inclusive, illustrate maintenance department organizations which have been established and are working in several large steel plants today. These charts may be used as a guide in forming a maintenance department, as they illustrate both centralized and decentralized organizations, with combinations of each.

Figure 5 is an outline of a complete organization setup for a maintenance department, covering all divisions of the combined electrical and mechanical departments. This chart outlines the responsibilities of the various foremen and the coordination of all of the divisions.

Being more familiar with organization chart, Figure 5, than the other types illustrated, we have outlined in detail the following charts showing complete divisional and shop organizations. Figures 6 to 9 inclusive, illustrate in detail the organizations for the divisional groups concerned with fixed operating maintenance and repairs. Figure 6 outlines in detail the duties and responsibilities of the electrical and mechanical groups in the blast furnace division. In this division, the work is divided into electrical and mechanical groups with a foreman over each group. The headquarters of these foremen, including their clerical force, is concentrated in one office, and in the event of the absence of either foreman, the other foreman assumes full responsibility. With this interlocking type of organization, each group becomes familiar with the problems and duties of the other, resulting in broader interests and better co-operation.

Figure 7 outlines the duties and responsibilities of the electrical and mechanical groups in the open hearth division. It will be noted that the type of supervision on this chart is somewhat changed, in that there is one general foreman over both the electrical and mechanical groups. The advantage of this particular setup is due primarily to physical layout and concentration of equipment.

FIGURE 4



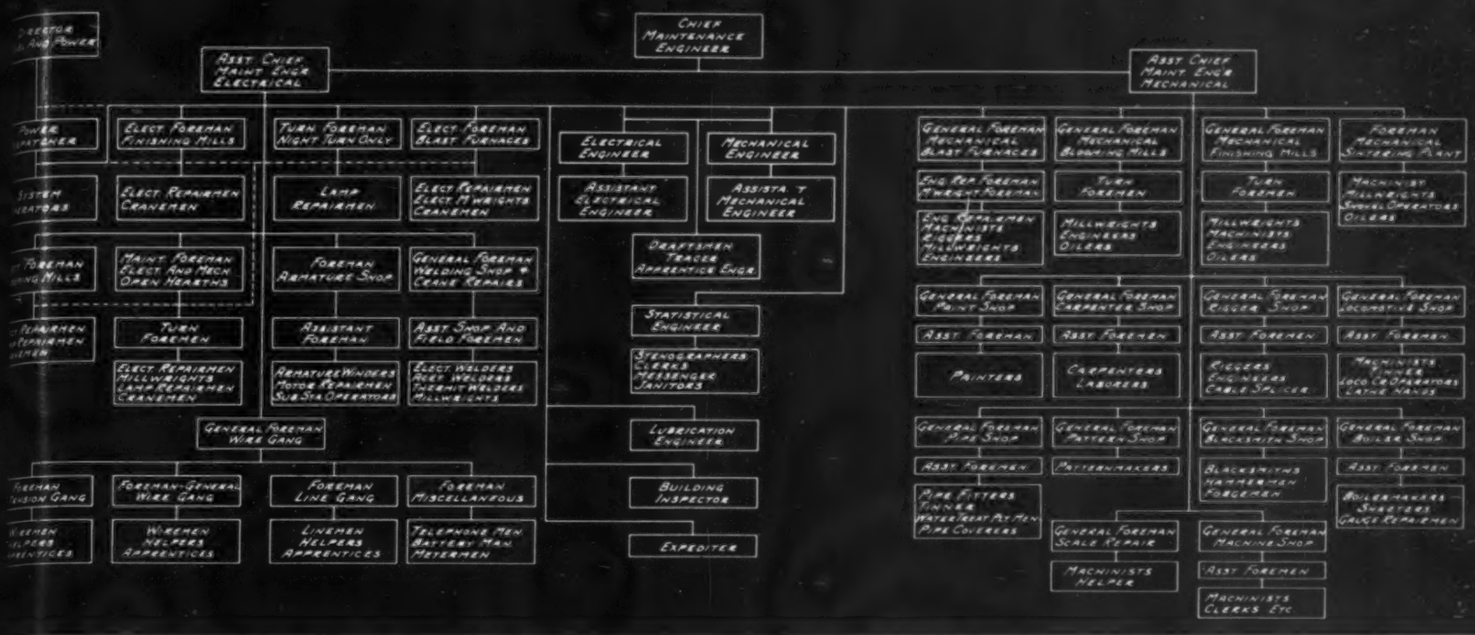


FIGURE 5

Figure 8 outlines the duties and responsibilities of the maintenance groups in the blooming mill division. This organization setup is practically a duplicate of that for the blast furnace division, with duties very similar and interlocked in the same manner.

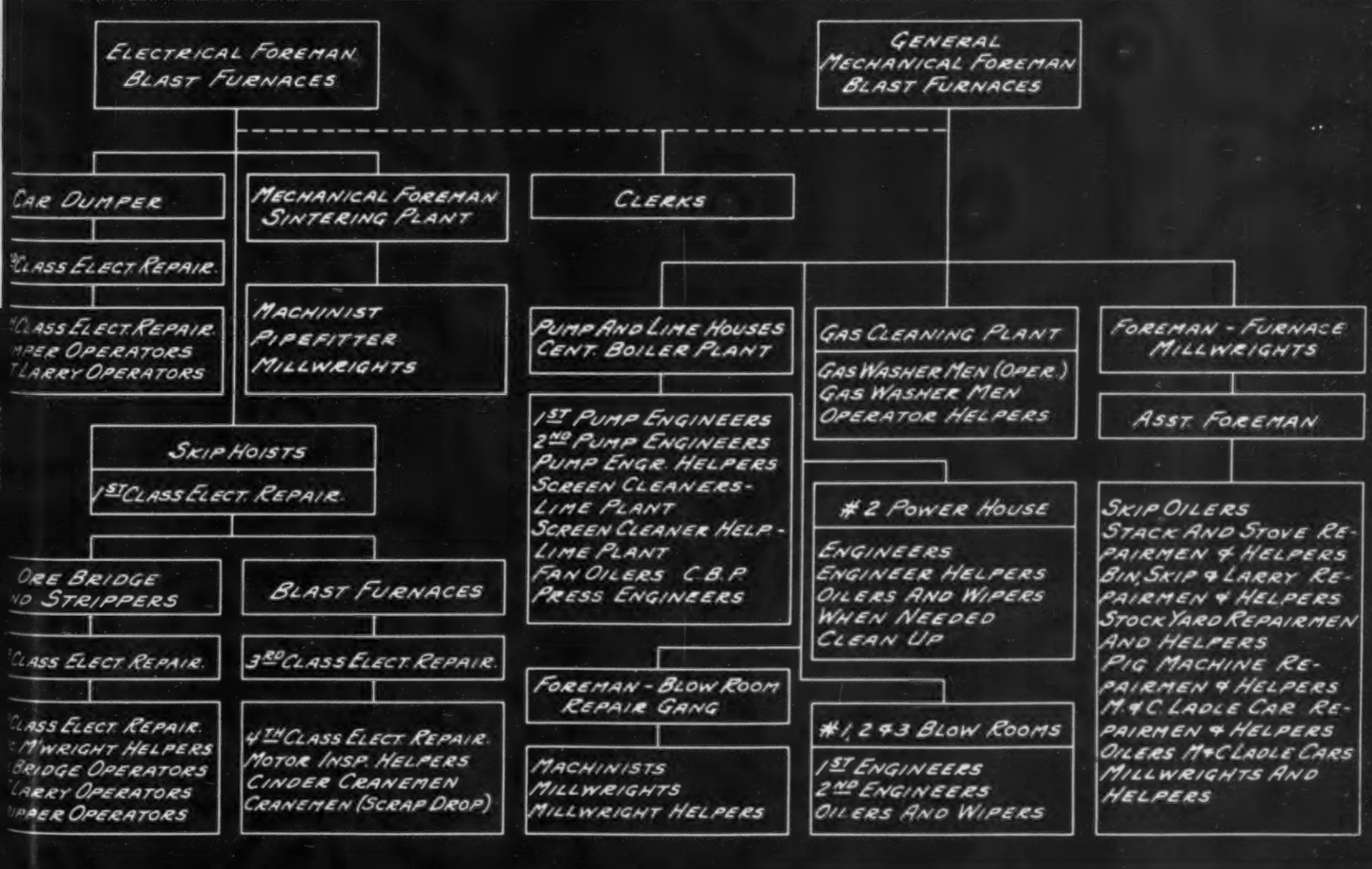
Figure 9 outlines the duties and responsibilities of the maintenance groups in the finishing mill division. The organization outlined here is practically a duplicate of the setup in the blast furnace and blooming mill divisions, with duties very similar and interlocked in the same manner.

The following group of charts, Figures 10 to 21 inclusive, covers in detail the organization and the duties performed by the shop and field forces. The duties of these groups include not only the actual shop work but also similar shop duties in the field, in maintenance and repairs, and in new construction work.

Figure 22 outlines the duties and responsibilities of the maintenance department engineering groups, both electrical and mechanical.

Figure 23 outlines the duties and responsibilities of the statistical and general clerical group.

FIGURE 6—Maintenance group—blast furnace division.


Electrical Foreman Blast Furnaces
General Mechanical Foreman Blast Furnaces
Car Dumper
Mechanical Foreman Sintering Plant
Clerks
2nd Class Elect. Repair.
Machinist Pipefitter Millwrights
Pump And Lime Houses Cent. Boiler Plant
Gas Cleaning Plant
Foreman - Furnace Millwrights
Gas Washer Men (Oper.) Gas Washer Men Operator Helpers
Asst. Foreman
Skip Hoists
1st Class Elect. Repair.
1st Pump Engineers 2nd Pump Engineers Pump Engr. Helpers Screen Cleaners - Lime Plant Screen Cleaner Help. - Lime Plant Fan Oilers C.B.P. Press Engineers
#2 Power House
Engineers Engineer Helpers Oilers And Wipers When Needed Clean Up
Ore Bridge And Strippers
Blast Furnaces
3rd Class Elect. Repair.
Foreman - Blow Room Repair Gang
#1, 2 & 3 Blow Rooms
1st Engineers 2nd Engineers Oilers And Wipers
Machinists Millwrights Millwright Helpers
Skip Oilers Stack And Stove Repairmen & Helpers Bin, Skip & Larry Repairmen & Helpers Stock Yard Repairmen And Helpers Pig Machine Repairmen & Helpers M. & C. Ladle Car Repairmen & Helpers Oilers M. & C. Ladle Cars Millwrights And Helpers

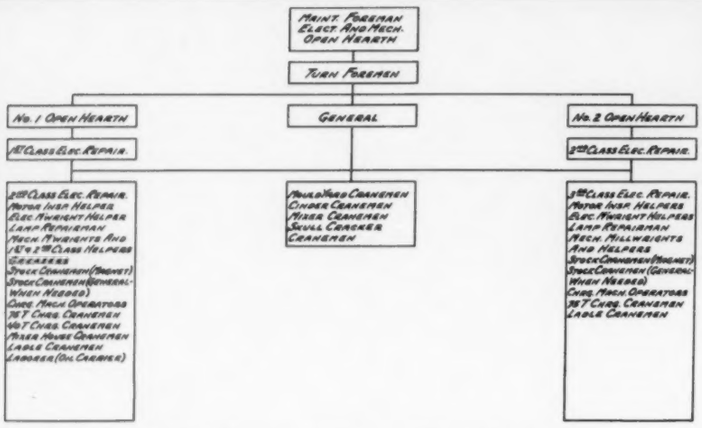

MAINT. FOREMAN ELECT. AND MECH. OPEN HEARTH
TURN FOREMAN
No. 1 OPEN HEARTH
GENERAL
No. 2 OPEN HEARTH
1ST CLASS ELEC. REPAIR.
2ND CLASS ELEC. REPAIR.
2ND CLASS ELEC. REPAIR. MOTOR INSP. HELPER ELEC. MAINT. HELPER LAMP REPAIRMAN MECH. MAINT. AND 1ST & 2ND CLASS HELPERS GREASERS STOCK CONNECTION (MAGNET) STOCK CONNECTION (GENERAL-WHEN NEEDED) CHIEF MACH. OPERATORS 75 T. CHARG. CRANEMEN 40 T. CHARG. CRANEMEN MIXER HOUSE CRANEMEN LADLE CRANEMEN LABORER (ON CHARGER)
MOULD YARD CRANEMEN CINDER CRANEMEN MIXER CRANEMEN SCRAP CHARGER CRANEMEN
3RD CLASS ELEC. REPAIR. MOTOR INSP. HELPERS ELEC. MAINT. HELPERS LAMP REPAIRMAN MECH. MILLWRIGHTS AND HELPERS STOCK CONNECTION (MAGNET) STOCK CONNECTION (GENERAL-WHEN NEEDED) CHIEF MACH. OPERATORS 75 T. CHARG. CRANEMEN LADLE CRANEMEN

FIGURE 7—Maintenance group—open hearth division.

Figure 24 outlines the duties and responsibilities of the lubricating engineer, building inspector and expeditor.

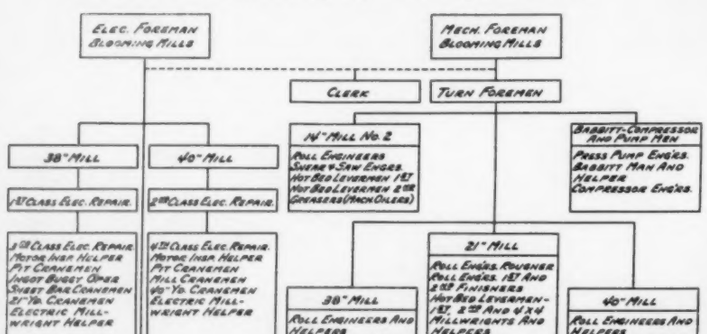
Figure 25 outlines the duties and responsibilities of the electrical turn foreman.

The organizations in many of our steel plants today consist of men who have long service. The lack of apprenticeship training during the recent depression has resulted in a deficiency in the younger group of trained men.

To have available younger men in our organizations, it behooves management to train its own craftsmen by the selection of apprentices and by hiring technically trained men for supervisory positions and engineering.

For craftsmen the maintenance department should have a clearly defined four-year apprenticeship course under the direction of the plant personnel department, and each year a new class of apprentices should be added. The number selected would depend on the

FIGURE 8—Maintenance group—blooming mill division.


ELEC. FOREMAN BLOOMING MILLS
MECH. FOREMAN BLOOMING MILLS
CLERK
TURN FOREMEN
38" MILL
40" MILL
14" MILL No. 2
ROLL ENGINEERS SHEAR & SAW ENGRS. HOT BED LEVERMAN 1ST HOT BED LEVERMAN 2ND GREASERS (MACH. OILERS)
BABBITT-COMPRESSOR AND PUMP MEN
PRESS PUMP ENG'RS. BABBITT MAN AND HELPER COMPRESSOR ENG'RS.
1ST CLASS ELEC. REPAIR.
2ND CLASS ELEC. REPAIR.
3RD CLASS ELEC. REPAIR. MOTOR INSP. HELPER PIT CRANEMEN INGOT BUGGY OPER. SHEET BAR CRANEMEN 25 TON CRANEMEN ELECTRIC MILLWRIGHT HELPER
4TH CLASS ELEC. REPAIR. MOTOR INSP. HELPER PIT CRANEMEN MILL CRANEMEN 40 TON CRANEMEN ELECTRIC MILLWRIGHT HELPER
21" MILL
ROLL ENGRS. ROUGHER ROLL ENGRS. 1ST AND 2ND FINISHERS HOT BED LEVERMAN-1ST, 2ND AND 4 X U MILLWRIGHTS AND HELPERS CONVEYORMEN GREASERS (MACHINE & CONDENSOR OILERS)
38" MILL
ROLL ENGINEERS AND HELPERS MILLWRIGHTS AND HELPERS GREASERS (MACHINE OILERS)
40" MILL
ROLL ENGINEERS AND HELPERS SHEAR & TABLE ENG'RS. LADLER (OILER AND WIPER) MILLWRIGHTS AND HELPERS GREASERS
LAMP REPAIRMAN

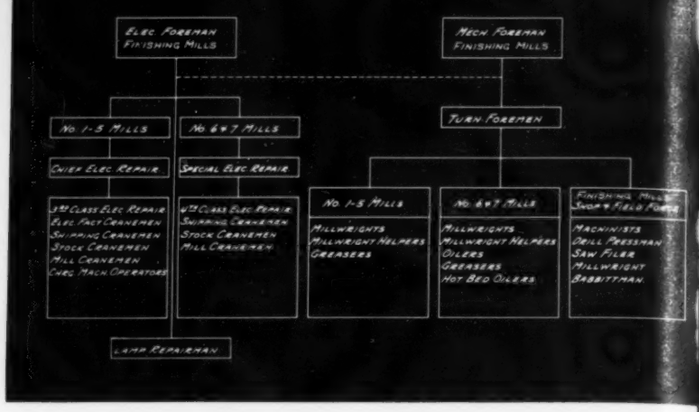
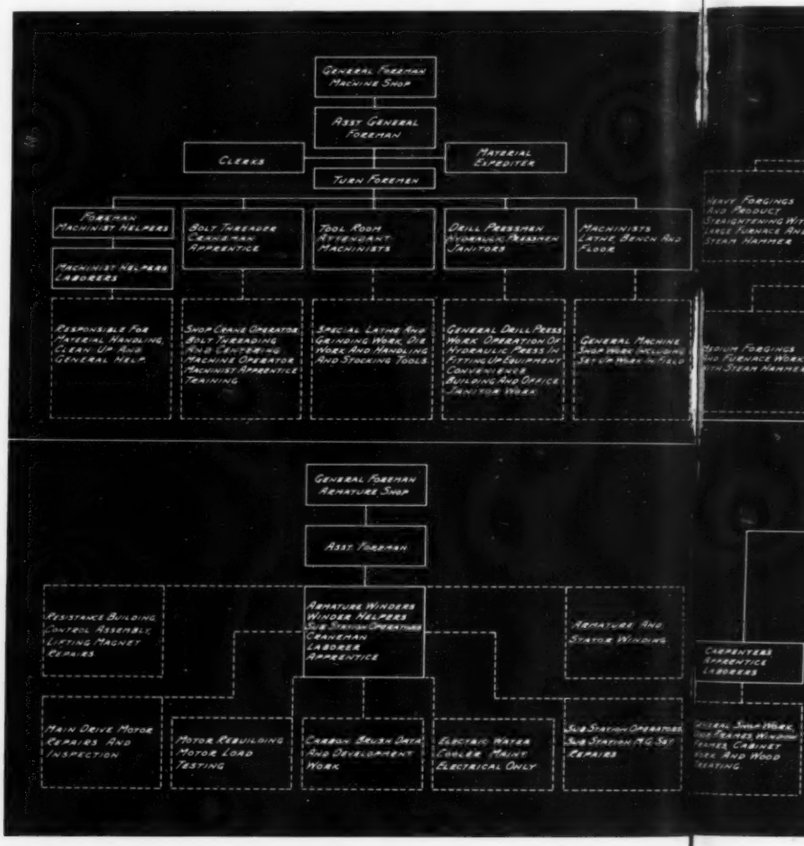

ELEC. FOREMAN FINISHING MILLS
MECH. FOREMAN FINISHING MILLS
No. 1-5 MILLS
No. 6 & 7 MILLS
TURN FOREMEN
CHIEF ELEC. REPAIR.
SPECIAL ELEC. REPAIR.
3RD CLASS ELEC. REPAIR. ELEC. FACT CRANEMEN SLIPPING CRANEMEN STOCK CRANEMEN MILL CRANEMEN CHIEF MACH. OPERATORS
4TH CLASS ELEC. REPAIR. SHEARING CRANEMEN STOCK CRANEMEN MILL CRANEMEN
No. 1-5 MILLS
MILLWRIGHTS MILLWRIGHT HELPERS GREASERS
No. 6 & 7 MILLS
MILLWRIGHTS MILLWRIGHT HELPERS OILERS GREASERS HOT BED OILERS
FINISHING MILLS SHOP & FIELD FORCE
MACHINISTS DRILL PRESSMAN SAW FILER MILLWRIGHT BABBITTMAN
LAMP REPAIRMAN

FIGURE 9—Maintenance group—finishing mill division.

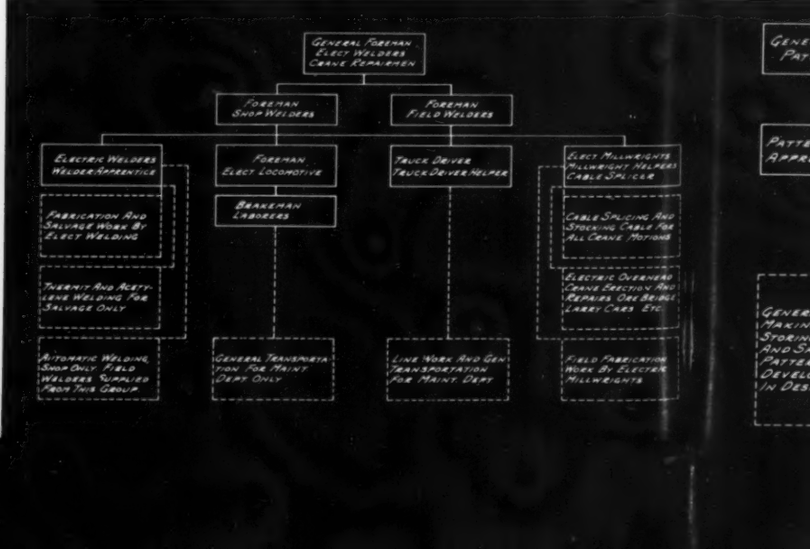
FIGURE 10—Machine shop.


GENERAL FOREMAN MACHINE SHOP
ASST. GENERAL FOREMAN
CLERKS
MATERIAL EXPEDITER
TURN FOREMEN
FOREMAN MACHINIST HELPERS
MACHINIST HELPERS LABORERS
BOLT THREADER CRANEMAN APPRENTICE
TOOL ROOM ATTENDANT MACHINISTS
DRILL PRESSMAN HYDRAULIC PRESSMEN JANITORS
MACHINISTS LATHE, BENCH AND FLOOR
RESPONSIBLE FOR MATERIAL HANDLING, CLEAN-UP AND GENERAL HELP
SHOP CRANE OPERATOR BOLT THREADING AND CENTERING MACHINE OPERATOR MACHINIST APPRENTICE TRAINING
SPECIAL LATHE AND GRINDING WORK, DIE WORK AND HANDLING AND STOCKING TOOLS
GENERAL DRILL PRESS WORK, OPERATION OF HYDRAULIC PRESS IN FITTING UP EQUIPMENT CONVENIENCES, BUILDING AND OFFICE JANITOR WORK
GENERAL MACHINE SHOP WORK INCLUDING SET UP WORK IN FIELD

GENERAL FOREMAN ARMATURE SHOP
ASST. FOREMAN
RESISTANCE BUILDING CONTROL ASSEMBLY LIFTING MAGNET REPAIRS
ARMATURE WINDERS WINDER HELPERS SUB STATION OPERATORS CRANEMAN LABORER APPRENTICE
ARMATURE AND STATOR WINDING
MAIN DRIVE MOTOR REPAIRS AND INSPECTION
MOTOR REBUILDING MOTOR LOAD TESTING
CARBON BRUSH DATA AND DEVELOPMENT WORK
ELECTRIC WELDER CRANE & MAINT. ELECTRICAL ONLY
SUB STATION OPERATORS SUB STATION H.V. SET REPAIRS

FIGURE 11—Electric repair shop.

FIGURE 12—Electric welding and crane repair group.


GENERAL FOREMAN ELECT. WELDERS CRANE REPAIRMEN
FOREMAN SHOP WELDERS
FOREMAN FIELD WELDERS
ELECTRIC WELDERS WELDER APPRENTICE
FOREMAN ELECT. LOCOMOTIVE
TRUCK DRIVER TRUCK DRIVER HELPER
ELECT. MILLWRIGHTS MILLWRIGHT HELPERS CABLE SPLICER
FABRICATION AND SALVAGE WORK BY ELECT. WELDING
BRAKEMAN LABORERS
CABLE SPLICING AND STOCKING CABLE FOR ALL CRANE MOTIONS
THERMIT AND ROSTLENE WELDING FOR SALVAGE ONLY
ELECTRIC OVERHEAD CRANE ERECTION AND REPAIRS, CAR BRAKE, LARRY CARS, ETC.
AUTOMATIC WELDING, SHOP ONLY. FIELD WELDERS SUPPLIED FROM THIS GROUP
GENERAL TRANSPORTATION FOR MAINT. DEPT. ONLY
LINE WORK AND GEN. TRANSPORTATION FOR MAINT. DEPT.
FIELD FABRICATION WORK BY ELECTRIC MILLWRIGHTS

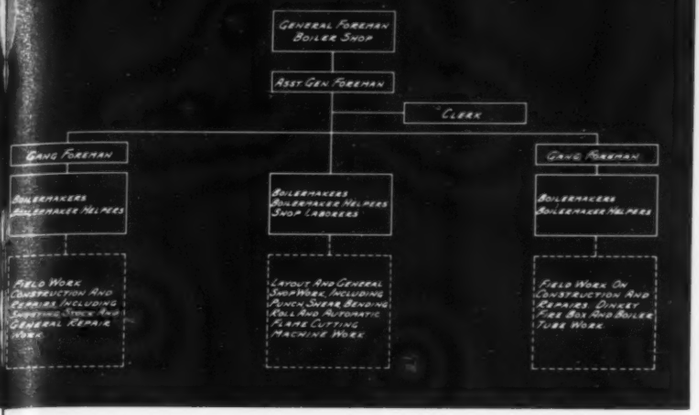

General Foreman Boiler Shop
Asst. Gen. Foreman
Clerk
Gang Foreman
Gang Foreman
Boilermakers Boilermaker Helpers
Boilermakers Boilermaker Helpers Shop Laborers
Boilermakers Boilermaker Helpers
Field Work Construction And Repairs Including Shoeing Stock And General Repair Work
Layout And General Shop Work Including Punch Shear Bending Roll And Automatic Flame Cutting Machine Work
Field Work On Construction And Repairs Dinkey Fire Box And Boiler Tube Work

FIGURE 13—Boiler shop.

FIGURE 14—Forge shop.

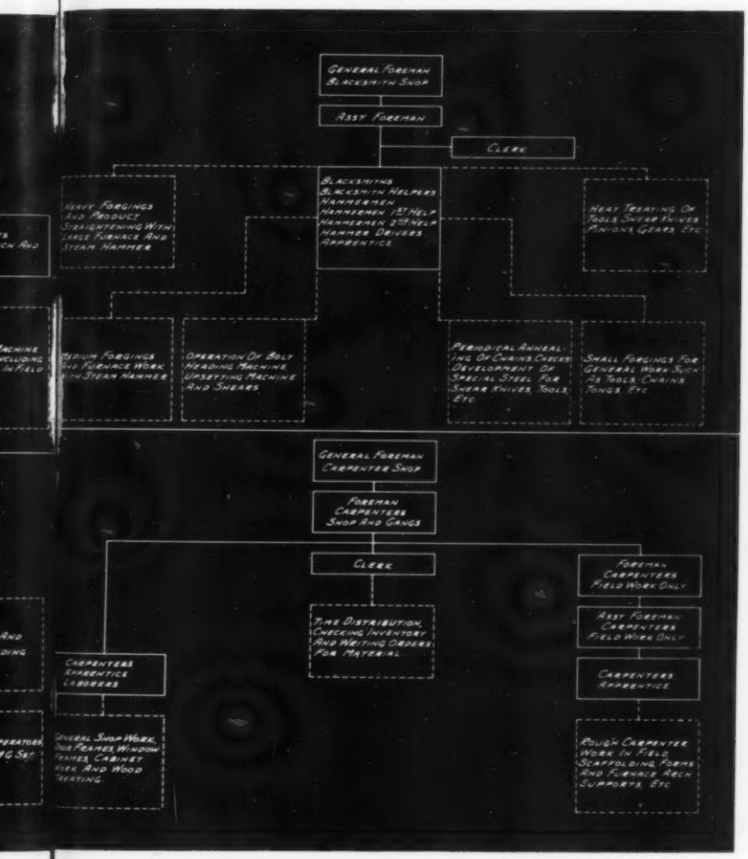
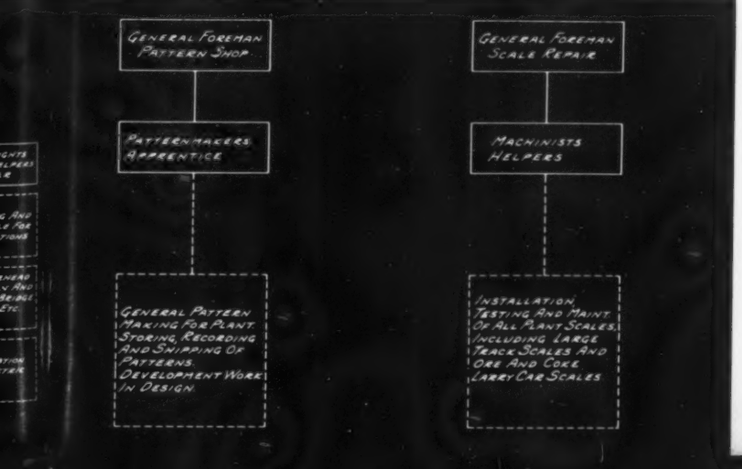

General Foreman Blacksmith Shop
Asst. Foreman
Clerk
Heavy Forgings And Product Straightening With Large Furnace And Steam Hammer
Blacksmiths Blacksmith Helpers Hammermen Hammermen 1st Helper Hammermen 2nd Helper Hammer Drivers Apprentice
Heat Treating Of Tools Shop Flywheels Pinions Gears Etc
Medium Forgings And Furnace Work With Steam Hammer
Operation Of Bolt Heading Machine Upsetting Machine And Shears
Periodical Annealing Of Chain Links Development Of Special Steel For Shear Knives Tools Etc
Small Forgings For General Work Such As Tools Chains Tongs Etc
General Foreman Carpenter Shop
Foreman Carpenters Shop And Gangs
Clerk
Foreman Carpenters Field Work Only
Time Distribution Checking Inventory And Writing Orders For Material
Asst. Foreman Carpenters Field Work Only
Carpenters Apprentice Laborers
Carpenters Apprentice
General Shop Work Pick Frames Window Frames Cabinet Work And Wood Treating
Rough Carpenter Work In Field Scaffolding Forms And Furnace Arch Supports Etc

FIGURE 15—Carpenter shop.

FIGURE 16—Pattern shop and scale repair.


General Foreman Pattern Shop
General Foreman Scale Repair
Pattern Makers Apprentice
Machinists Helpers
General Pattern Making For Plant Storing Recording And Shipping Of Patterns Development Work In Design
Installation Testing And Maint. Of All Plant Scales Including Large Track Scales And Ore And Coke Larry Car Scales

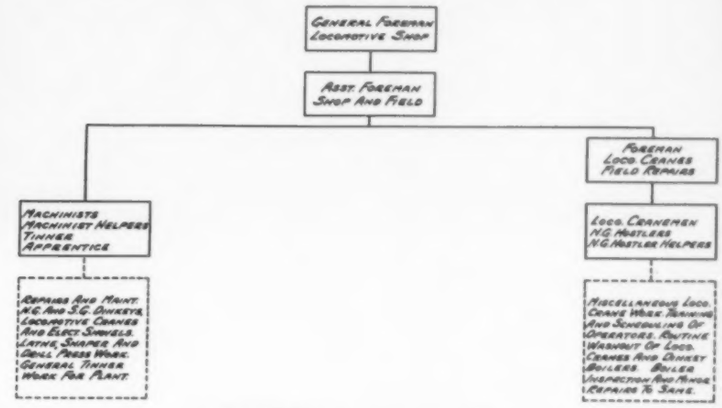

General Foreman Locomotive Shop
Asst. Foreman Shop And Field
Foreman Loco. Cranes Field Repairs
Machinists Machinist Helpers Tinner Apprentice
Loco. Cranemen N.G. Hostlers N.G. Hostler Helpers
Repairs And Maint. N.G. And S.G. Diesels Locomotive Cranes And Elect. Shovels Lathe Shaper And Drill Press Work General Tinner Work For Plant
Miscellaneous Loco. Crane Work Training And Scheduling Of Operators Routine Washout Of Loco. Cranes And Dinkey Boilers Boiler Inspection And Minor Repairs To Same

FIGURE 17—Locomotive shop.

requirements in the various shops and gangs. The selection of apprentices would be made by competitive tests, based on education and personality.

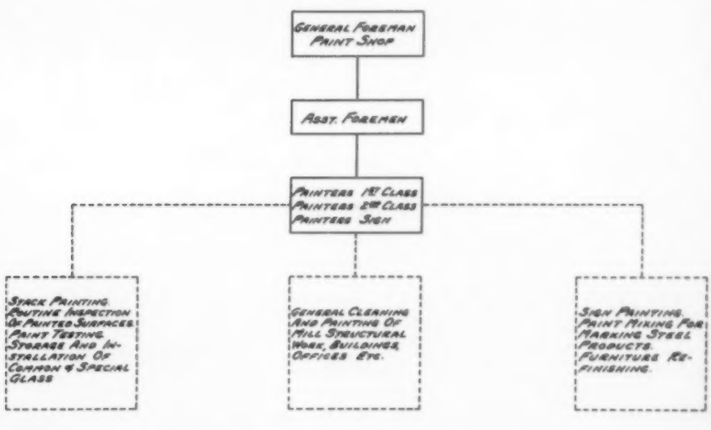
Of men having a background of technical training, a definite number should be selected, both electrical and mechanical, each year, depending on requirements. The number should be approximately twice the recommended requirements, to take care of shrinkage.

Having once selected a group of such men, it is necessary that they be handled under a definite schedule of training for experience, and it is also desirable that their earnings be increased as the value of their services to the company increases. Upon completion of the training period they should be assigned a definite occupation, depending on ability and the positions open.

With the above outlined program, the department should have at all times a supply of trained follow-up men and an efficient organization.

Having developed a well-rounded organization, and

FIGURE 18—Paint shop.


General Foreman Paint Shop
Asst. Foremen
Painters 1st Class Painters 2nd Class Painters Sign
Stock Painting Routine Inspection Of Painted Surfaces Paint Testing Storage And Installation Of Common & Special Glass
General Cleaning And Painting Of Mill Structural Work Buildings Offices Etc.
Sign Painting Paint Mixing For Marking Steel Products Furniture Refinishing

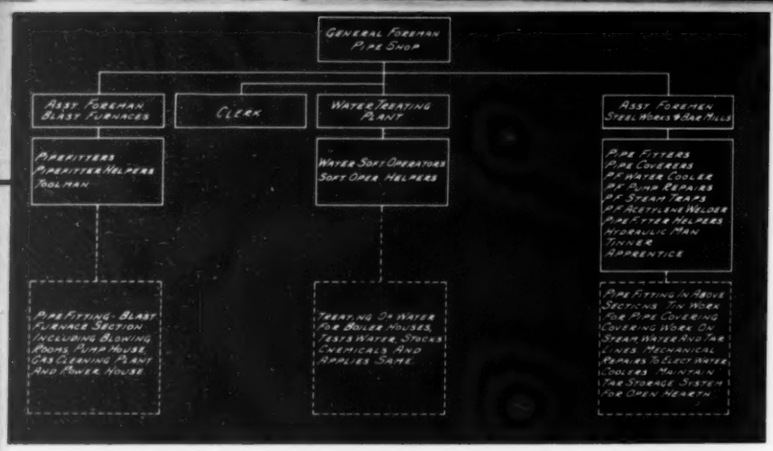

General Foreman Pipe Shop
Asst. Foreman Blast Furnaces
Clerk
Water Treating Plant
Asst. Foremen Steel Works & Bar Mills
Pipefitters Pipefitter Helpers Tool Man
Water Soft Operators Soft. Oper. Helpers
Pipe Fitters Pipe Coverers Ast. Water Cooler Air Pump Repairs Air Steam Traps Air Acetylene Welder Air Fitter & Helpers Hydraulic Man Tinner Apprentice
Pipe Fitting - Blast Furnace Section Including Blowing Irons, Pump House, Gas Cleaning Plant And Power House
Treating Of Water For Boiler Houses, Tests Water, Stocks Chemicals And Applies Same.
Pipe Fitting In Above Sections On Work For Pipe Covering Covering Work On Steam Water And Tar Lines, Mechanical Repairs To Elect Water Coolers, Maintain Tar Storage System For Open Hearth

FIGURE 19—Pipe shop.

FIGURE 20—Rigging gang.

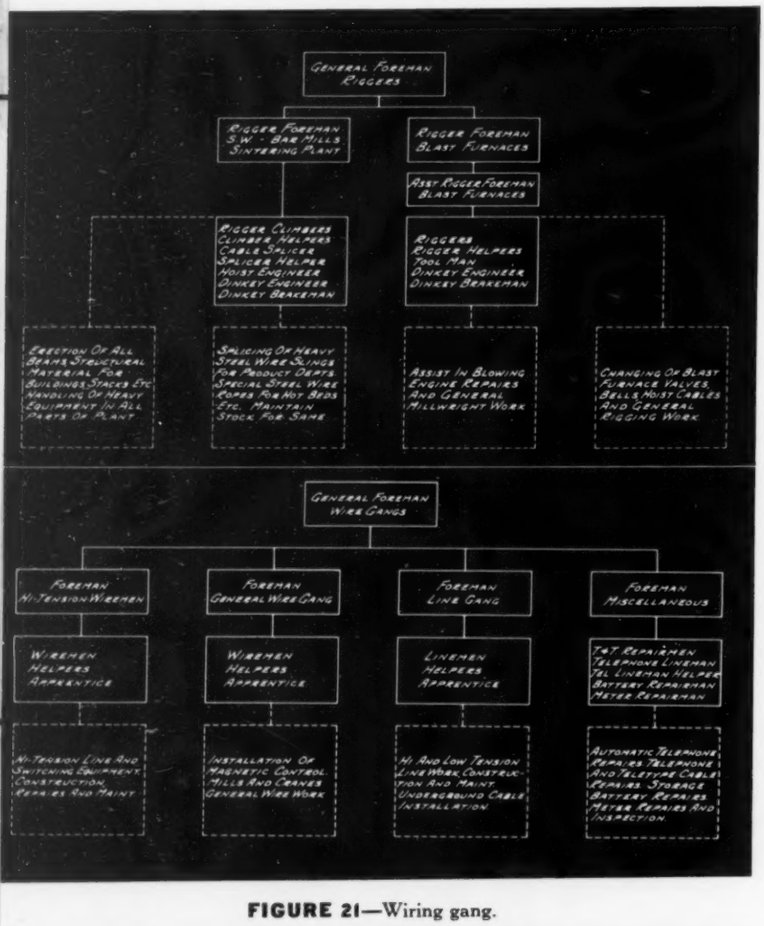
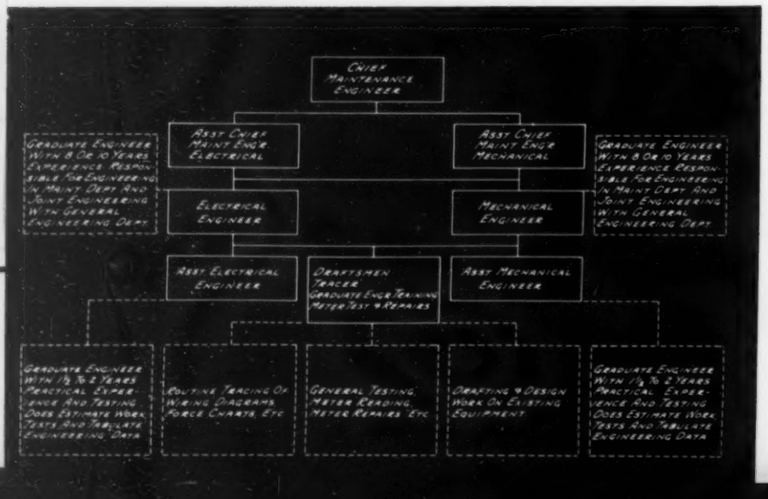

General Foreman Riggers
Rigger Foreman S.W. - Bar Mills Sintering Plant
Rigger Foreman Blast Furnaces
Asst. Rigger Foreman Blast Furnaces
Rigger Climbers Climber Helpers Cable Splicer Splicer Helper Hoist Engineer Dinkey Engineer Dinkey Brakeman
Riggers Rigger Helpers Tool Man Dinkey Engineer Dinkey Brakeman
Erection Of All Beams, Structural Material For Buildings Stacks Etc Handling Of Heavy Equipment In All Parts Of Plant.
Splicing Of Heavy Steel Wire Slings For Product Charts, Special Steel Wire Ropes For Hot Beds Etc. Maintain Stock For Same
Assist In Blowing Engine Repairs And General Millwright Work
Changing Of Blast Furnace Valves, Bells, Hoist Cables And General Rigging Work
General Foreman Wire Gangs
Foreman Hi-Tension Wiremen
Foreman General Wire Gang
Foreman Line Gang
Foreman Miscellaneous
Wiremen Helpers Apprentice
Wiremen Helpers Apprentice
Linemen Helpers Apprentice
T&T. Repairmen Telephone Lineman Tel. Lineman Helper Battery Repairman Meter Repairman
Hi-Tension Line And Switching Equipment Construction, Repairs And Maint.
Installation Of Magnetic Control Mills And Cranes General Wire Work
Hi And Low Tension Line Work Construction And Maint. Underground Cable Installation
Automatic Telephone Repairs Telephone And Telegraph Cable Repairs Storage Battery Repairs Meter Repairs And Inspection.

FIGURE 21—Wiring gang.

FIGURE 22—Maintenance engineering.


Chief Maintenance Engineer
Graduate Engineer With 8 Or 10 Years Experience Passible For Engineering In Maint. Dept And Joint Engineering With General Engineering Dept.
Asst. Chief Maint. Engr. Electrical
Asst. Chief Maint. Engr. Mechanical
Graduate Engineer With 8 Or 10 Years Experience Passible For Engineering In Maint. Dept And Joint Engineering With General Engineering Dept.
Electrical Engineer
Mechanical Engineer
Asst. Electrical Engineer
Draftsmen Tracer Graduate Engr. Training Meter Test & Repairs
Asst. Mechanical Engineer
Graduate Engineer With 1½ To 2 Years Practical Experience And Testing Does Estimate Work Tests And Tabulate Engineering Data
Routine Tracing Of Wiring Diagrams Force Charts, Etc
General Testing Meter Reading Meter Repairs Etc
Drafting & Design Work On Existing Equipment
Graduate Engineer With 1½ To 2 Years Practical Experience And Testing Does Estimate Work Tests And Tabulate Engineering Data

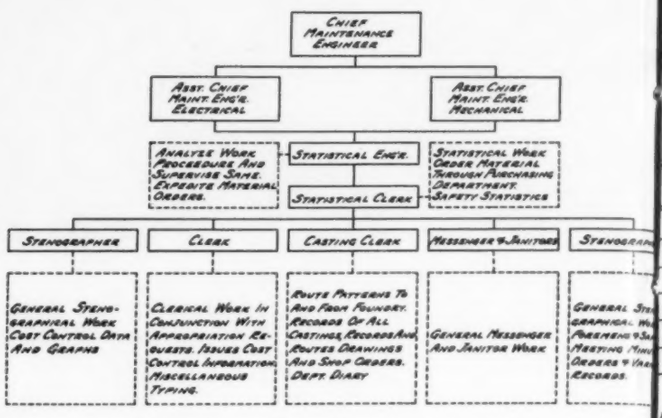

Chief Maintenance Engineer
Asst. Chief Maint. Engr. Electrical
Asst. Chief Maint. Engr. Mechanical
Analyze Work Procedure And Supervise Same. Expedite Material Orders.
Statistical Engr.
Statistical Clerk
Statistical Work Order Material Through Purchasing Department Safety Statistics
Stenographer
Clerk
Casting Clerk
Messenger & Janitor
Stenographer
General Stenographical Work Cost Control Data And Graphs
Clerical Work In Conjunction With Appropriation Requests Issues Cost Control Information Miscellaneous Typing.
Route Patterns To And From Foundry. Records Of All Castings Records And Routes Drawings And Shop Orders. Dept. Diary
General Messenger And Janitor Work

FIGURE 23—Statistical and general clerical group.

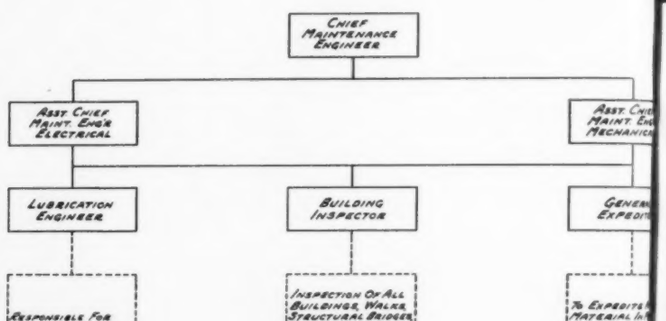
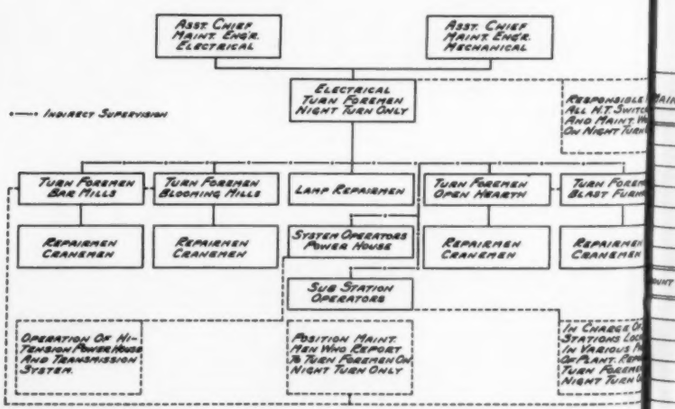

Chief Maintenance Engineer
Asst. Chief Maint. Engr. Electrical
Lubrication Engineer
Building Inspector
Responsible For All Plant Lubricants Lubricating Systems Maint. And General Development Work For Same
Inspection Of All Buildings Walks Structural Bridges Tanks Trestles Etc. Set Up Schedule For Repairs Cleaning And Painting.

FIGURE 24—Lubrication engineer, building inspector and general exp

FIGURE 25—Electrical turn foreman.


Asst. Chief Maint. Engr. Electrical
Asst. Chief Maint. Engr. Mechanical
Indirect Supervision
Electrical Turn Foreman Night Turn Only
Turn Foremen Bar Mills
Turn Foremen Blooming Mills
Lamp Repairmen
Turn Foremen Open Hearth
Repairmen Cranemen
Repairmen Cranemen
System Operators Power House
Repairmen Cranemen
Sub Station Operators
Operation Of Hi-Tension Power House And Transmission System.
Position Maint. Man Who Report To Turn Foreman On Night Turn Only

Store Room Material Requisition

Machine or Floor Motor No. _____ Motion Repaired _____

Job No. _____

Acct. No. _____

Date _____ 19__

Store Keeper:

Please Furnish Maintenance Department

Description	Quantity	Price	Amount	Class

Part Repaired (Cross Out Two) Motor / Control / Mechanical Signed _____

FIGURE 26

arranged for a dependable supply of competent men to replace those who retire or leave the service, it is essential that the maintenance group be provided with a system of cost accounting permitting quick analysis of the possibilities of effecting economies.

This cost system should be simple, but giving sufficient detailed cost data, so that plant costs can be compared weekly or monthly; also that comparisons can be made with other plants producing similar material.

As a matter of comparison, it is essential that in as far as practical, accurate budgets of man hours should be set up for the respective departments and divisions. This will enable the foremen to watch currently their costs, and detect any leaks provided their charges and budgets are accurate. If the budget hours cannot be met with reasonable accuracy, there is something wrong, and the industrial engineering department

FIGURE 27

Time Distribution

Maintenance Department _____ Shop Time Card _____ 19__

Name	Check Number	Hours	Name	Check Number	Hours

Amount	Hours	Job Number Or Equip. No.	Machine Number	Description Of Labor

_____ Foreman

Purchase Material Requisition

_____ Works

Req. No. _____ Date: _____ 19__

Order No. _____

Gen. Supt. - Please Order As Follows:

		Stock On Hand And On Order

Account No. _____

" " _____

Approved: _____ Signed: _____

Gen. Supt.

FIGURE 28

FIGURE 29

Shop Order

Mach. Or Floor Motor No. _____ Sup'ts. Order No. _____

Mr. _____ 19__

Please Furnish For _____ Dep't.

For Use On _____ Charging Same To

Account No. _____ For Labor

" " _____ For Mat'l.

Signed _____

Dept. Sup't.

No. Pcs.	Description	Mat'l.	Dwg. No.	Mark	Patt. No.	Location Of Mat'l.

Department Superintendents And Others Will Insert The Machine Or Floor Motor Number Or Numbers On All Orders For Work On Equipment Covered By The Book Of "Machine And Floor Motor Numbers" Indicating Also The Department And Equipment And Describing Fully The Work To Be Done.

should be called in to make a check and either substantiate the budget or make necessary corrections.

Along with the above, it is also essential that we have an accurate cost finding or job cost department. Having established a job cost department, it is necessary that all departments, divisions and equipment have proper charge accounts and equipment numbers. With this established, no work should be done without first having a job cost number issued by the job cost department, assigning a number to an order properly made out by foreman for work to be done, and having this order approved by a department head. An order having been approved, and having been assigned a job number, all labor and any material used in execution of work on this order should be charged to its job number. If the work proceeds as outlined; when it is completed, an accurate account of labor and material charged to the job should be available in one week. It is then possible to check items and ascertain if the engineering estimates were over or under, and the reason therefor.

For a cost finding system to be efficient, as above outlined, special requisition forms and time slips must be adopted and used. As an example, Figure 26 is a typical stores requisition form for material checked from general stores; Figure 27 is a sample shop time card for daily distribution of labor; Figure 28 is a typical requisition form for ordering special material through the Purchasing Department; and Figure 29 illustrates a job cost order form for handling material and labor chargeable to respective jobs; Figure 30 is a monthly departmental record covering total labor and

FIGURE 30

JOB COST DEP'T. _____ WORKS

REPAIR AND MAINTENANCE RECORD

PRODUCTS DEP'T. ROLLING MILLS MONTH _____ YEAR _____

ACCOUNT NO.	REPAIR AND EQUIP. NO.	DESCRIPTION	COST	
			LABOR	MAT'L.
D284A	4623	BLOOMER ENGINE - 40" MILL		
D284C	4023	NO.3 PIT CRANE -38" MILL		
D2006E	2067	NO.1 CRANE CENTRAL SCRAP PLT.		
2011A2B	5116	NO.1 AIR COMPRESSOR - BAR MILLS		
294M	4731	ROLL TRAIN PINIONS NO.1 SET-21" MILL		
353B	4160	VERTICAL EDGER - 14" MILL NO.1		
HP1B	4142	NO.1 ELECT. HYD. PUMP - STEEL WORKS		
		TOTALS		

SUMMARY

SHOPS	HOURS	AMOUNT	COST PER TON
MACHINE SHOP			
LOCO. SHOP			
LOCO. CRANES			
BOILER SHOP			
BLACKSMITH SHOP			
PIPE SHOP			
CARPENTER SHOP			
PAINT SHOP			
RIGGER SHOPS			
SCALE REPAIRMEN			
BAR MILL MECHANICAL			
ARMATURE SHOP			
ELECTRIC GANG			
WELDING SHOP			
DRAUGHTSMEN			
GENERAL LABOR			
BRICK LAYERS			
BRICK HELPERS			
TOTAL LABOR COST			
TOTAL MAT'L. COST			
REFRACTORY MAT'L.			
STORES + BILLS			

TONS OF PRODUCT PRODUCED _____

FIGURE 31

DATE: _____

MR. _____

STATUS OF MAINTENANCE DEP'T. COST CONTROL

BUDGET FROM _____ TO _____

SHOP OR GANG	ALLOTT.	SPENT	OVER RUN	LESS SPECIAL + EXTRA JOBS	NET OVER RUN	% OVER RUN	D-16 ACCT
MACH. SHOP							
LOCO. SHOP							
LOCO. CRANE							
BOILER SHOP							
BLACKSMITH							
PIPE SHOP							
CARP. - PATT.							
PAINT SHOP							
RIGGER SHOP							
GENERAL MECH.							
SCALE REPAIR							
BAR M. MECH.							
ARMATURE SHOP							
ELEC. GANG							
WELD. + MWR.							
TOTALS							
POSITIONS							
BLAST FCE.							
OPEN HEARTH							
ROLLING MILLS							
BAR MILLS							
ALL OTHERS							
CHIPPING							
SCRAP PLANT							
SINT. PLANT							
TOTALS							
DEP'T. TOTALS							

DEPARTMENT	ALLOTT.	SPENT	OVER RUN	% OVER RUN	EXTRA JOBS	NET OVER RUN	% NET OVER RUN
BLAST FCE.							
OPEN HEARTH							
ROLLING MILLS							
BAR MILLS							
ALL OTHERS							
CHIPPING							
SCRAP PLANT							
SINT. PLANT							
TOTALS							

SIGNED: _____

material costs, also distribution of the shop and field labor.

Figure 31 is a budget form used for showing the status of man hours used by the various maintenance department foremen, and Figure 32 is a sample form for the weekly assignment of man hours to the various foremen.

The value to be derived from any cost system depends primarily on its accuracy, simplicity, availability, and the methods and manner of use.

In closing this particular phase of the paper, we present the following charts:

Figures 33 and 34—Used for setting up man hour bogeys for the various maintenance groups.

Figure 35—"Tendency" or "Expectancy" curves based on present and past performances.

FIGURE 32—Weekly man-hour forecast.

To: Mr. _____ Foreman Date: _____

From: Chief Maintenance Engineer.

Subject: Cost Control Budget - Week Of _____

Your Budget Of Operating Hours Exclusive Of DW And Special Allowance Jobs, Based On Forecasted Tonnages, Chargeable To The Various Departments, For The Week Is Shown Below:

Department	Blast Fces.	Open Hrth.	Bloom Mills	Bar Mills	Misc.	Scrap Plant	Chip.	Sint. Plant	Total
Forecast Tonnages									
Allotted Man Hours									
Machine Shop									
Locomotive Shop									
Locomotive Crane									
Boiler Shop									
Blacksmith Shop									
Pipe Shop									
Carp. & Patt. Shop									
Paint Shop									
Riggers - S.W. & B.F.									
General Mechanical									
Scale Repairmen									
Bar Mill Mechanical									
Armature Shop									
Electric Gang									
Welding Shop									
Overtime Mill Positions									
Total									

Signed: _____

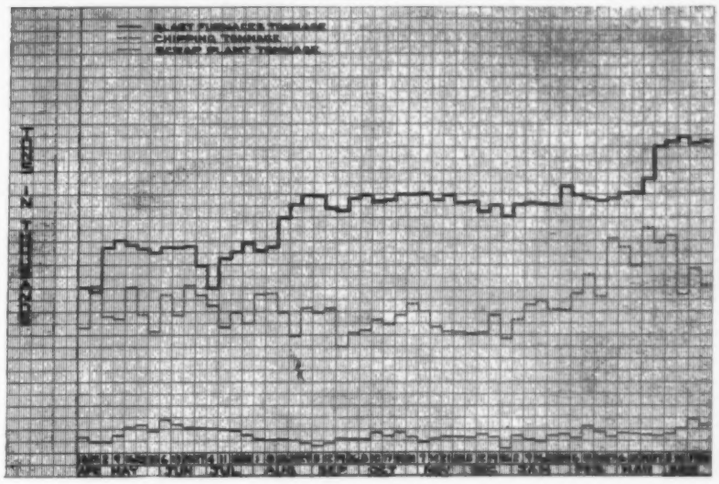


FIGURE 33—Tonnage chart used for arriving at man-hour bogeys.

FIGURE 34—Man-hour chart based on forecasted tonnage.

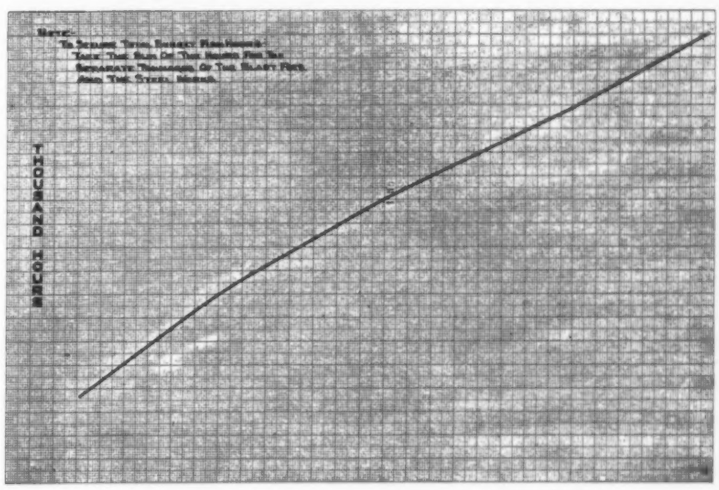
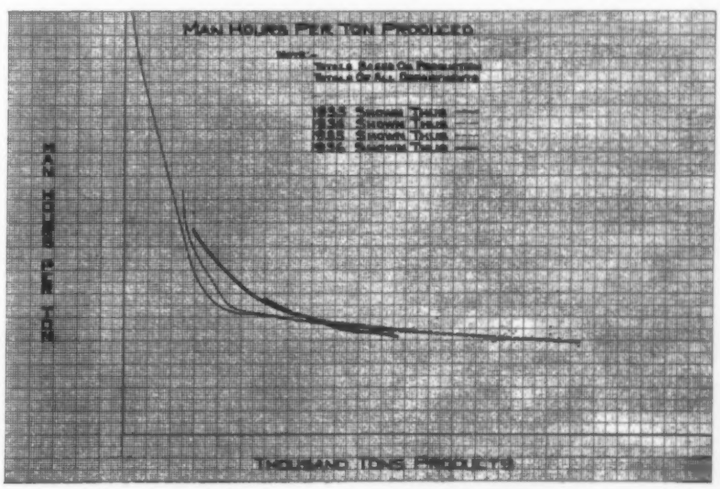


FIGURE 35—Tendency or expectency curves.



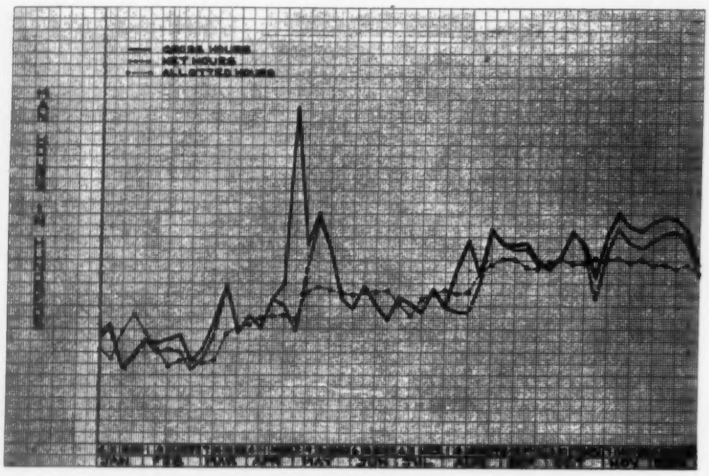


FIGURE 36

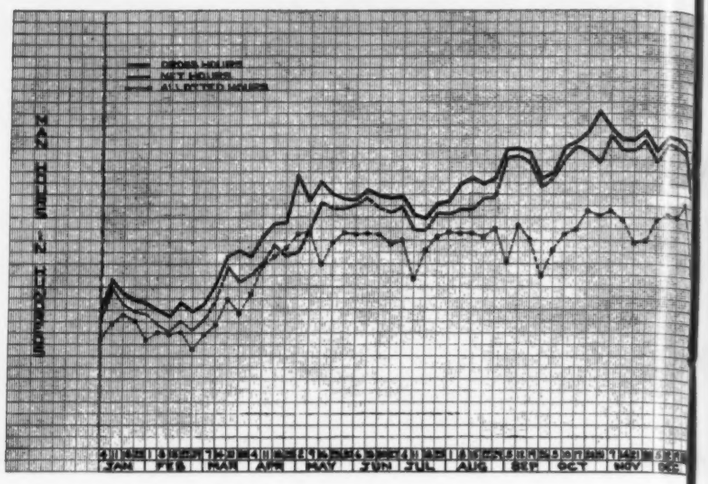


FIGURE 38

Figure 36—Sample of chart maintained for each producing department, for indicating the status of man hours charged.

Figure 37—Indicates the total maintenance department distribution hours charged to all plant operations.

Figure 38—Sample of man hour chart used for each group in the maintenance department.

Figures 39 and 40—This type of chart is used for showing actual maintenance department man hours per ton of product output of each department.

Having developed a method of cost finding and arranged for a system of tabulating the information, which deals principally with man-power, it is then the duty of the maintenance group to consider methods of

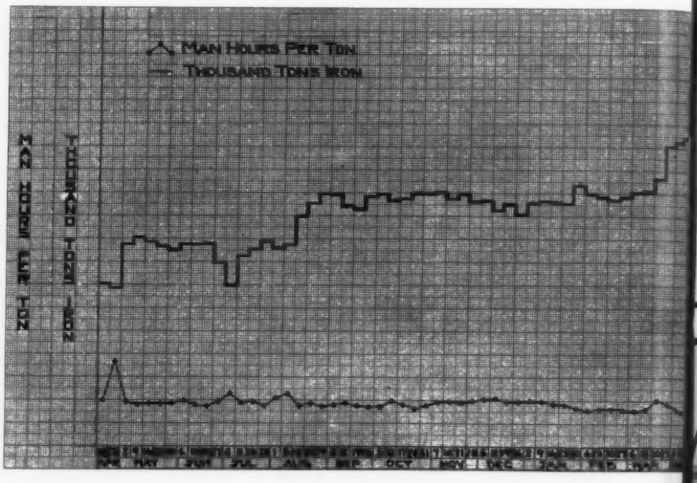


FIGURE 39

FIGURE 37

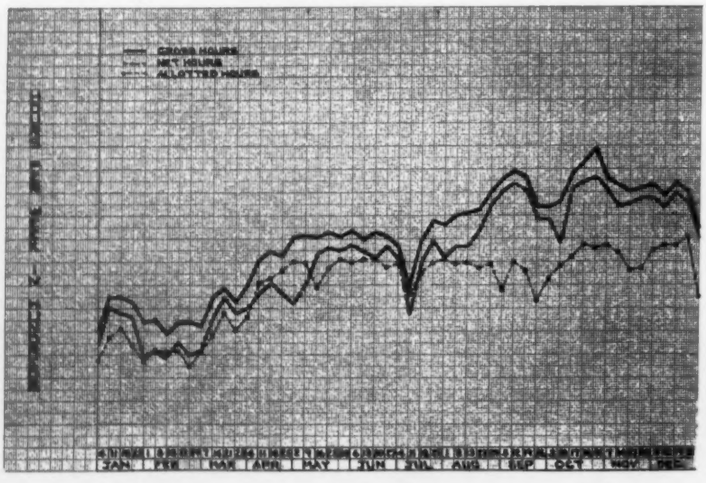
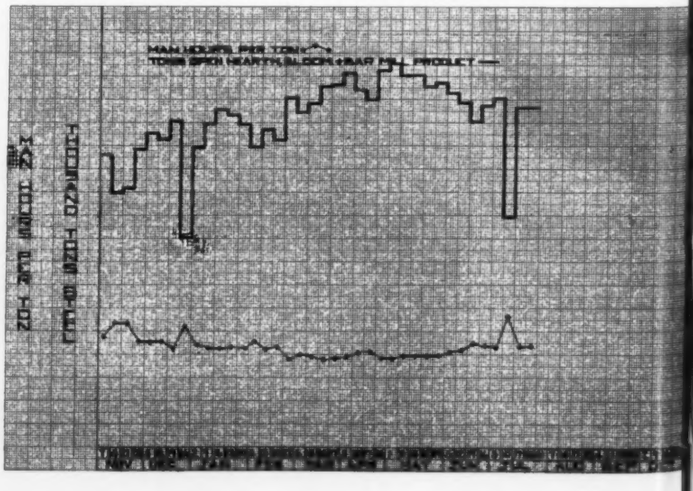


FIGURE 40



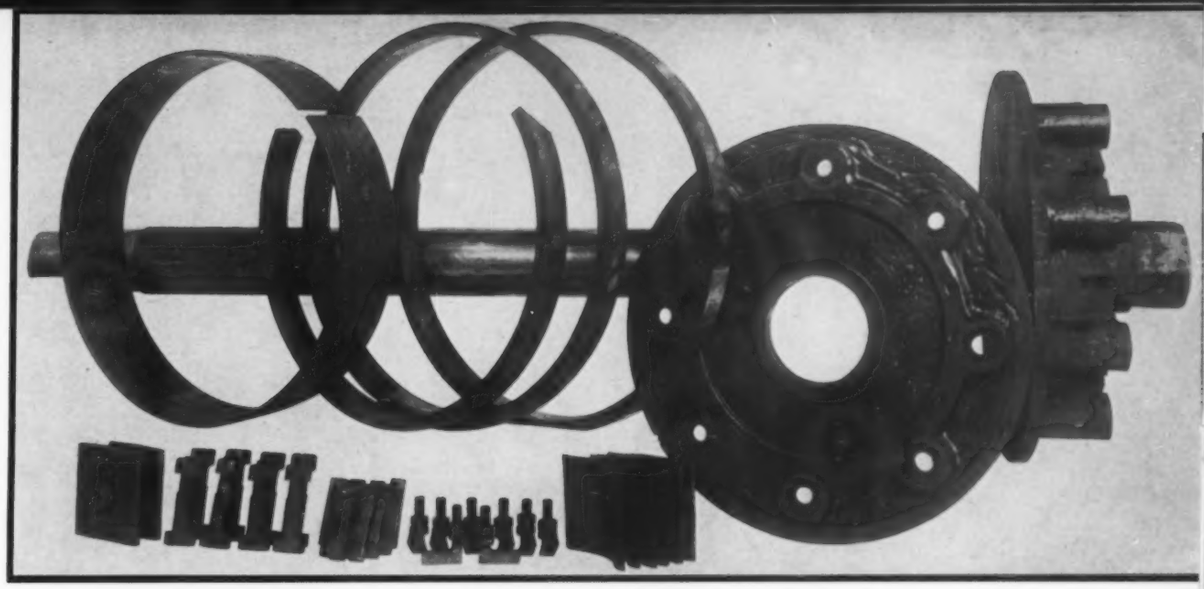


FIGURE 43

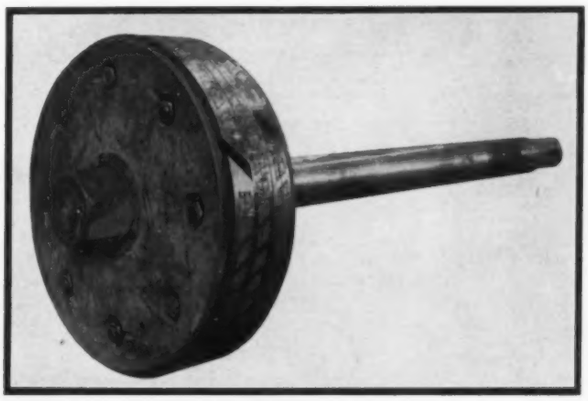


FIGURE 44

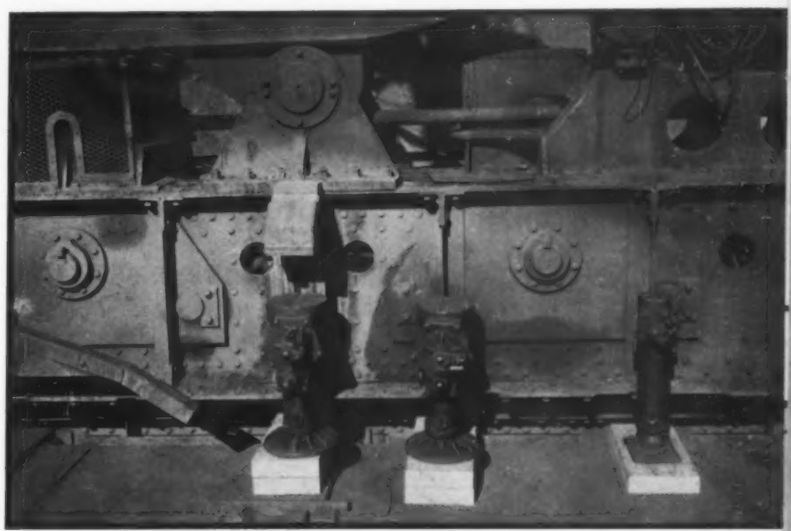


FIGURE 45

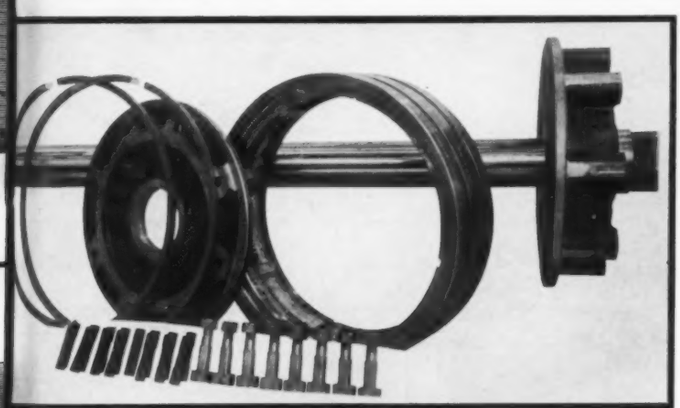
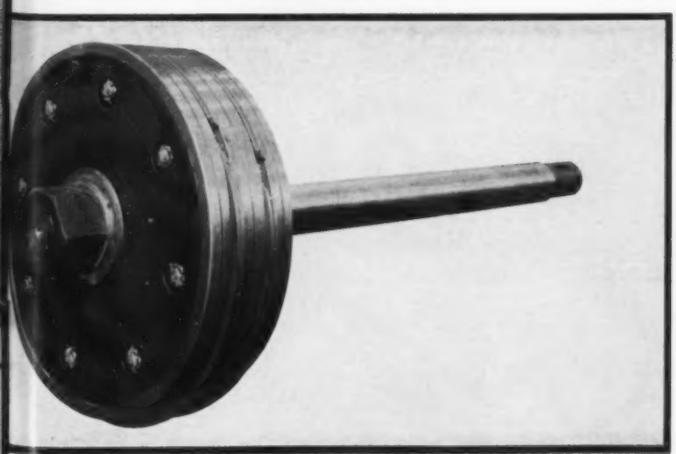
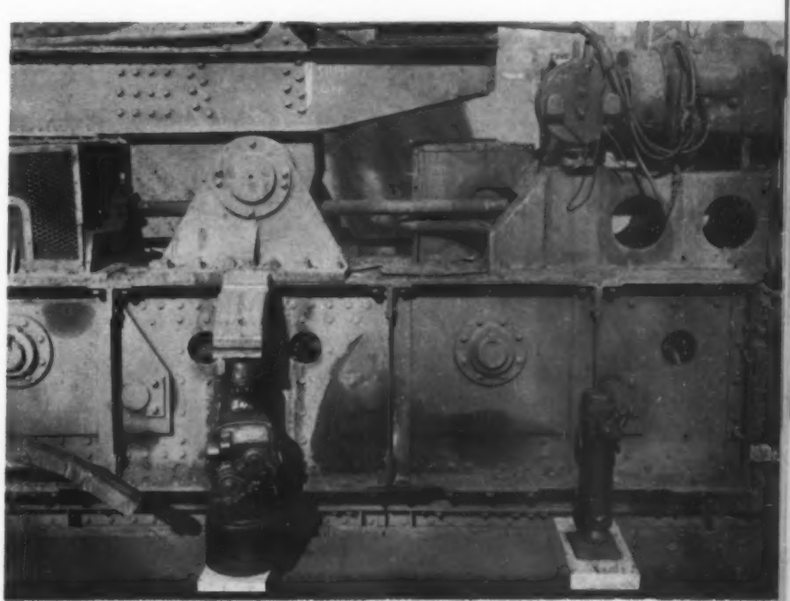


FIGURE 41

FIGURE 42

FIGURE 46





cost reduction, and some means of compiling that information for study.

There are several angles from which cost reduction can be approached, and we have chosen maintenance and improvements to existing equipment as those that control the problem in a major way.

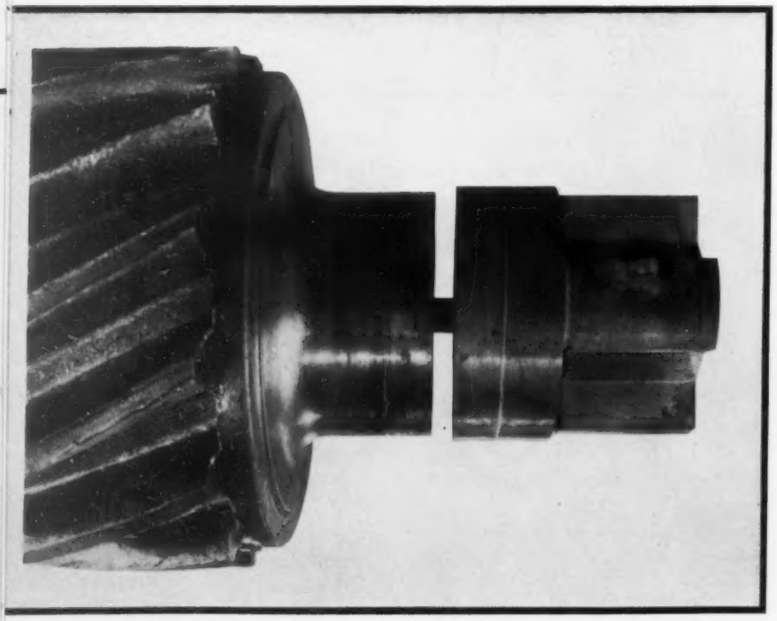
Economical results cannot be obtained in the installation and maintenance of new equipment unless the producing, the general engineering, and the maintenance departments cooperate in the selection of design of equipment and the planning of its installation. With this cooperation, installations which will result in extravagant maintenance should be avoided. Through the same cooperation, standard types of equipment can be established, thereby reducing the number of renewal parts required.

To carry out the program of development study referred to previously in this paper, the following setup is essential:

(1) A group of men in the maintenance department having both technical and practical training, and competent to make necessary tests as required.

(2) All equipment necessary for making complete electrical and mechanical tests.

FIGURE 47—New wobbler in place.



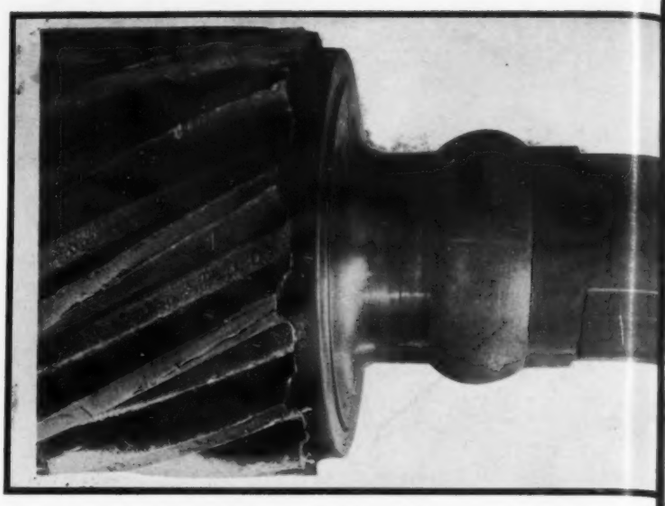
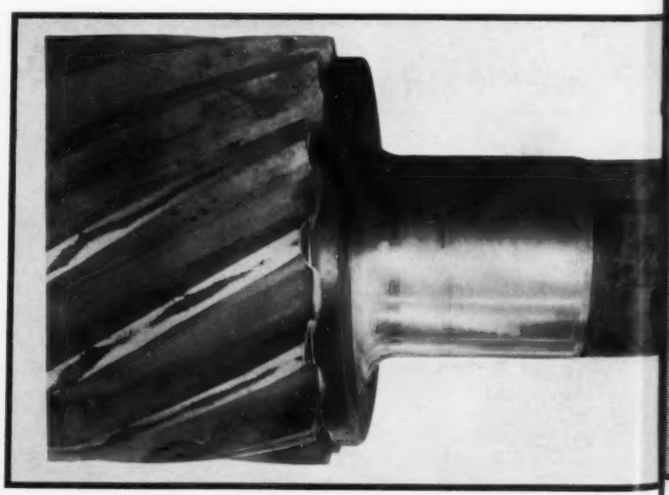


FIGURE 48—Waxed and ready for sand mold.

FIGURE 49—Thermit weld completed.

FIGURE 50—Welding and machining completed.



MAINTENANCE DEPARTMENT

DAILY REPORT OF SAFETY LEADER

_____ NOTICE ANY CARELESS OR UNSAFE PRACTICE THAT MIGHT HAVE CAUSED AN ACCIDENT? _____

DETAILS _____

REPORT SAME TO YOUR FOREMAN? _____ WHEN? _____

ACTION WAS TAKEN? _____

SEE ANY BAD ORDER IN YOUR DEPT.? _____ DID YOU REPORT SAME TO FOREMAN? _____

ACTION WAS TAKEN? _____

TALK TO YOUR GROUP ON SAFETY TO-DAY? _____ DID YOU TALK TO YOUR GROUP ON WASTE PREVENTION? _____

MARKS USE OTHER SIDE OF THIS FORM

NAME _____ CHECK _____

DEPARTMENT _____

FIGURE 51

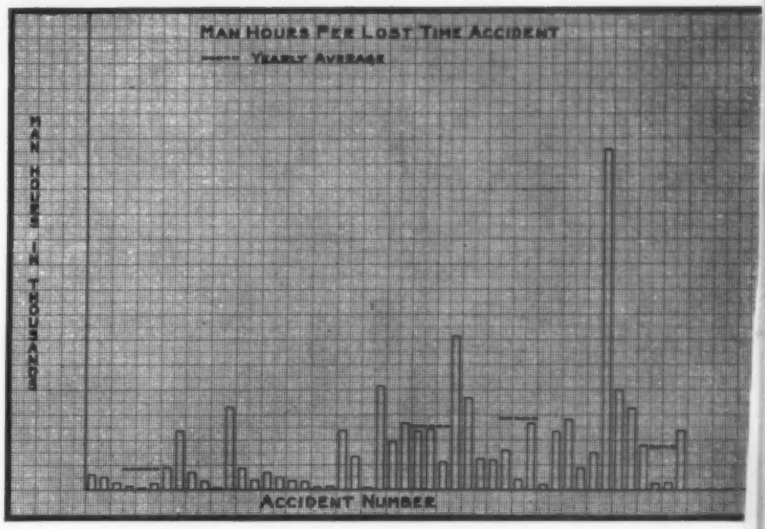


FIGURE 53

(3) A definite policy for department heads and foremen visiting other plants of similar type to exchange ideas. Also, these men should be encouraged to attend the various Engineering Society meetings.

We believe that one of the most practical methods of helping to keep mill machinery modern is by the use of photographs. Photographs usually can be taken readily, and they quickly convey definite ideas as to general outline, design and, in a measure, operation of machinery.

We submit as samples, the following illustrations, which we believe are self-explanatory and indicate the points mentioned above.

Figures 41 to 44 inclusive, illustrate the old and new design of a piston and piston rod for a reversing mill engine. Figures 41 and 42 illustrate the new design with a minimum number of parts. Figures 43 and 44 illustrate the old design with its many parts.

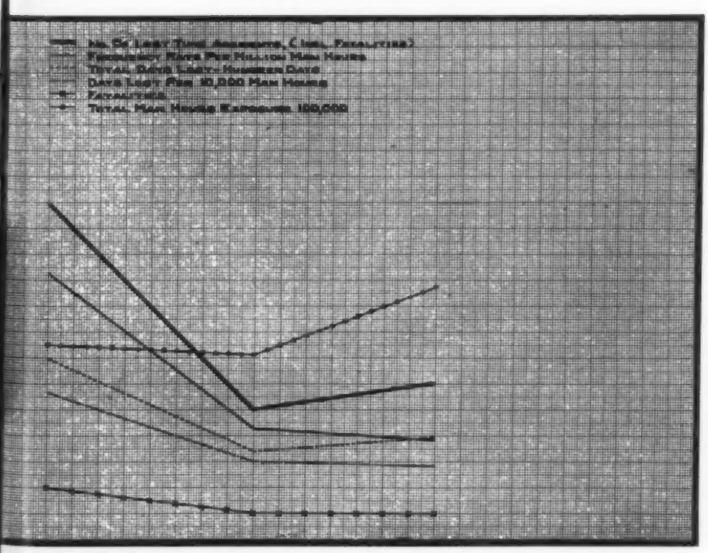
Figures 45 and 46 illustrate the old and new methods of changing ore bridge track wheels. The old method required three jacks, with the heel of jack under bottom cord of end trucks. The new method uses only one jack for lifting from head of jack, and a smaller jack for tilting end trucks.

Figures 47 to 50 inclusive, illustrate the welding of large blooming mill pinions by the use of Thermit process.

To make the above information and data of the most value, it is necessary that a complete, convenient filing system be established.

Two important items connected with the operation of a maintenance department are safety and good housekeeping. Safe workmen are one of the greatest

FIGURE 52



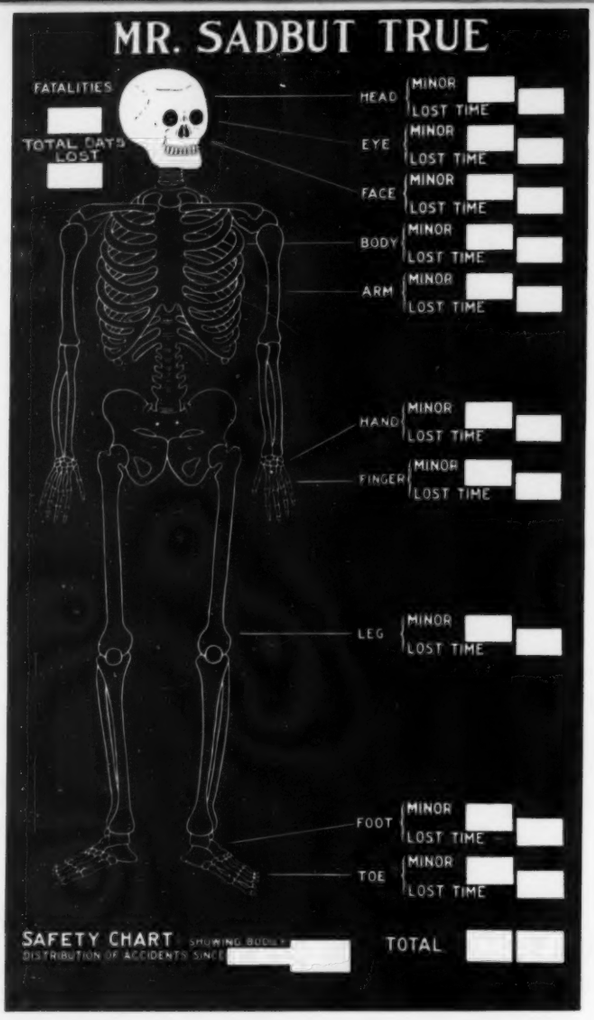


FIGURE 55—Ladder in safety position—operator in cab.

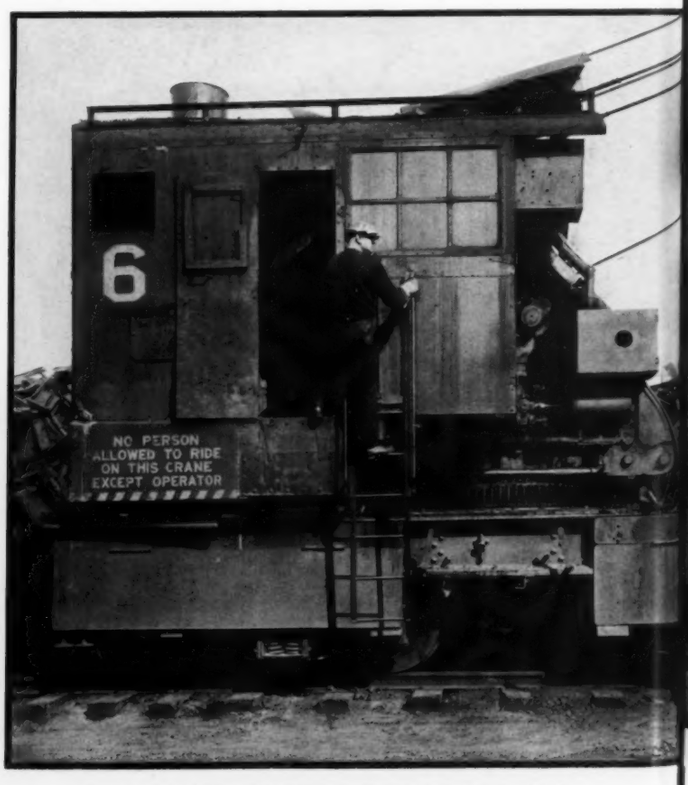
assets a company can have, and to have safe workmen there must be an alert safety department for the entire plant, whose duty it is to insist on work being done in a safe manner, and machinery being equipped with safety devices and guards. Having established in the plant an efficient safety department, it is then the duty of the operating and maintenance departments to train their men so that they think safety at home, on the road and in the mills. To train men along the lines of safety, first the department heads must believe whole heartedly in safety. They pass the safety spirit on to the foremen, who in turn have the greatest opportunities of teaching safety to the operating men. It is also necessary to have safety rallies, safety meetings, and group safety talks.

Good results have been obtained in the task of spreading the safety spirit by having safety observers in the different divisions, whose duty it is to report unsafe practices and conditions to the office, as well as calling attention of the men on the job and in the field to violations.

Having instilled safety into the minds of the men, it is also necessary that they have good tools, machinery properly guarded, proper aisles, stairways, hand railings,

FIGURE 54

FIGURE 56—Preparing ladder for descent.



good roads, and in general, good housekeeping throughout the plant. Clean, properly ventilated buildings, mills and shops, lend a good atmosphere for the men to work in safely. Poor working conditions, such as unguarded machinery, oil and grease on machinery and floors, poor methods of getting on and off machinery and crane runways, are conducive to accidents and poor workmanship, all of which increase not only minor accidents, but lost time accidents and casualties.

As mentioned above, the Maintenance Department organization has a definite responsibility for the safety of their men. Records of the results obtained from the maintenance department's own safety efforts should be in sufficient detail to permit scrutiny at all times for the purpose of keeping minor and lost time accidents under control. In short, these records are just as important as cost records, and therefore should receive the same detail study.

The following sample sketches and photographs are a few of the many types of records that can be used successfully for the purpose mentioned above.

Figure 51 is an outline of the report used by maintenance department safety leaders for reporting unsafe practices and poor working conditions, as noted by them in the various parts of the plant.

Figure 52 illustrates the method of tabulating information received from the safety leader reports.

Figure 53 is used for indicating the relation between minor and lost time accidents, based on number of minor for each lost time accident.

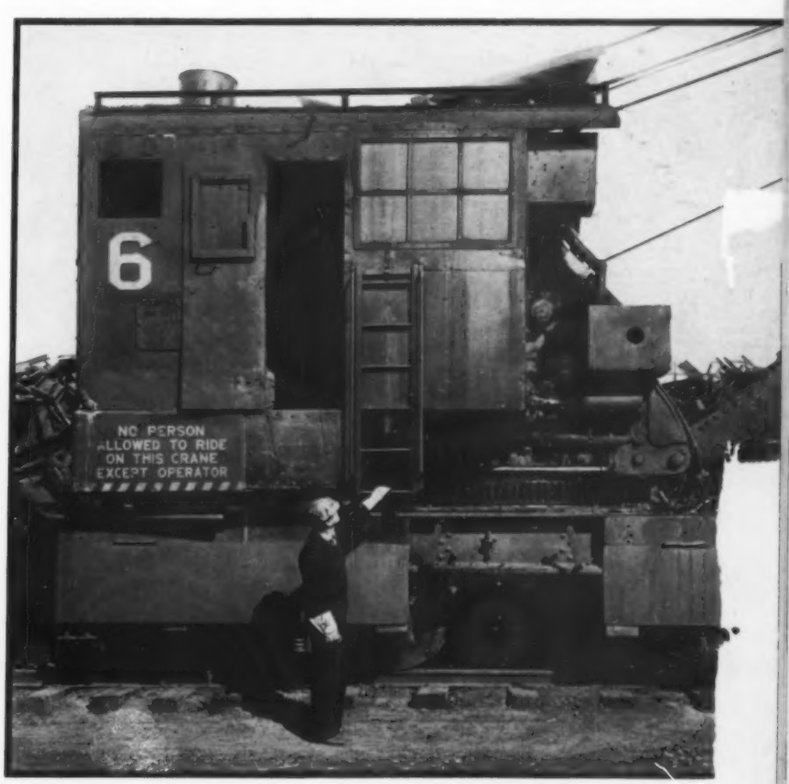
Figure 54 has been found to be rather effective in determining the parts of the human body affected by current type of accidents.

Figures 55 to 58 inclusive, illustrate the various positions of a newly designed safety ladder, installed on locomotive cranes for use of the operator in getting to and from his cab.

In conclusion, the maintenance department of a steel plant is a well organized, sizeable group, having nothing to sell except experience and service, yet it reaches into the far corners of the mills and departments of the plant; installing and maintaining equipment; keeping machinery in constant service; studying costs, efficiency, and modern equipment; training young men, both apprentices and technically trained men; teaching safety at all times, and endeavoring to cooperate with all departments.

FIGURE 57——Operator descending.

FIGURE 58—Descent completed—ladder automatically returns to safety position.



DISCUSSION

PRESENTED BY

A. W. STEED, Supt. Maintenance, American Rolling Mill Company, Middletown, Ohio.

C. J. SMITH, Supt. Maintenance Dept., Carnegie-Illinois Steel Corp., Gary, Indiana.

E. W. TREXLER, Supt. Maintenance, Bethlehem Steel Company, Johnstown, Pa.

T. E. HUGHES, Chief Maintenance Engineer, Carnegie-Illinois Steel Corp., Duquesne, Pa.

HARVEY DEMMON, Supt. Maintenance Dept., Farrel-Mercer Works, Carnegie-Illinois Steel Corp., Farrel, Pa.

J. J. BOOTH, Asst. Chief Maintenance Engineer, Carnegie-Illinois Steel Corp., Duquesne, Pa.

A. W. STEED: Mr. Hughes and Mr. Booth have given us a very fine picture of the maintenance organization in a major steel plant. They have also given us a lot to think about. As we are rather limited in our time this morning, I am going to put this thing up to you fellows just the way it would be put up to you in your plant.

You have a breakdown or an emergency facing you and it is very important that the job be completed in forty minutes so that the mills can start rolling on the next order. When your maintenance crew realize the importance of getting the job completed in forty minutes, they will break their necks to get it done.

Now we have thirty to forty minutes in which to discuss the paper just presented by Mr. Hughes, and it is a real emergency, to try and discuss this excellent paper in so short a time. Let's get into it just as though we were called in to fix a breakdown. This is an emergency, so let's get going.

MEMBER: Mr. Chairman, I think Mr. Hughes is certainly to be congratulated for venturing to propose such a paper and to present it. There certainly is a growing realization on the part of management of the necessity of better organization of maintenance departments. I have made a few notes from which I will illustrate some minor deviations from Mr. Hughes' various reported plans which may or may not have some merit. I note that it is customary in certain large sections of the country for locomotive crane operation to come under the maintenance department. In some plants that is not the practice; locomotive crane maintenance is under the supervision of the transportation department, which department controls standard transportation, the advantage being that in unloading cars lifts and locomotive train service go hand in hand.

Another point that I might mention is the question of brick laying. In any major general construction or general repair job or minor repair job of course brick laying is a very valuable item. There are maintenance departments organized in which a brick department is under the maintenance department, also general labor, the purpose being to consolidate all organizations that have to do with any particular repair job.

C. J. SMITH: I have enjoyed listening to Mr. Hughes' paper very much because it has covered practically every problem which is of interest to me personally in the development of a maintenance setup. I believe that Mr. Hughes' point as to the desirability of definite organization is very important. We all know that the maintenance work can be highly centralized or partially decentralized and it can work fairly successfully either way, but the principal point is that it should be definitely organized so that the maintenance department can recognize and accept its responsibilities, exercising definite authority and assuming definite responsibility.

The discussion relative to budgeting of the work is very interesting. I can't say that we have accomplished a whole lot along that line but it is one of our problems—the planning and budgeting of the work.

The safety features incorporated in the article seem quite appropriate too in view of the fact that it is this organization which practically originated the safety movement in industry and which was instrumental in organizing the National Safety Council.

The mentioning by Mr. Hughes of the function of the industrial engineer is also very interesting. That is a new tool, new to us at least, but one which is proving quite effective. The industrial engineers can analyze our problems from a detached viewpoint and have no necessarily preconceived ideas as to how to do the job. Not having been responsible for the installation of equipment or practices, particularly where it is a new outfit, they can attack problems with an entirely open mind and from an analytical standpoint and I think we are going to find them a very useful tool in the work of the maintenance organization. Thank you.

E. W. TREXLER: Mr. Hughes has given us a fine paper. I would like to have him tell us how he applies the various charts on budgeting and costs. Does he have weekly meetings with foremen where the items are discussed? In other words, what does he consider the best way to get everybody in the department familiar with the various economies and information which he gathers on charts?

I believe that most maintenance departments are attempting to do the same thing that Mr. Hughes is doing, but many times the information comes to the superintendent's or the assistant's desk and may not get to the person who really can benefit by the information and accomplish the results we are after. The paper is excellent and I am very glad I was present to hear it.

T. E. HUGHES: The procedure of applying the various budget and cost sheets is as follows:

Each supervisor receives a man hour bogey for his weekly operations two days prior to the start of a new week, which is based on the forecast tonnage for the various operating departments. This information is checked daily in order to guard against sudden changes

in the actual tonnage schedule, and to check his actual hours used from day to day. This information is also made available to his assistants.

A graphical record is maintained for the purpose of checking the performance of each group and once a week the charts shown here today, together with other detail charts, are projected on the screen and each man is required to report on any unusual condition pertaining to his particular group. The attendance of this meeting includes the maintenance department engineering force and all shop, gang and position foremen.

The success of this scheme, or most any similar scheme of cost control, depends almost entirely on getting the information to the men closely associated with the work.

Regarding the other gentleman's question pertaining to locomotive cranes, the advantage of having the maintenance department responsible for locomotive crane repairs and the crane operators, as I see the matter, is due to the fact that the operators are chosen from the shop group where they have had experience in repair of the equipment. They should be better qualified as to the crane's capacity and to make minor repairs.

H. DEMMON: I might say that at the present time I am working along with Mr. Hughes in an effort to combine the sheet and tin and steel works of our particular plant. I am quite familiar with his organization; I think he has done a very fine job of preparing this paper. At the present time we are attempting to go a little further in centralizing supervision, and we hope to take in a few departments which Mr. Hughes has not combined in his plant. We are working towards taking in power and masonry, as well as mechanical and electrical under the centralizing supervision of the superintendent of maintenance.

J. J. BOOTH: Mr. Chairman and fellow members of the Association: In so far as this paper is concerned, Mr. Hughes and I have only attempted to give you something which we believe will be a guide in the future for organizing maintenance departments. It is immaterial how many departments are covered from the standpoint of central supervision. You may include the masonry, the paint shop, or any other department you wish, as we see it, so long as you have the proper control and the proper supervision.

Concerning costs, we have attempted to give you, briefly, a system in a rather short and concise manner, giving special emphasis to proper records of cost and man hours. Along with the cost budget, the man hours and the tonnage records, the industrial engineer plays an important part in measuring the production, and we feel that great benefits will be derived from the full cooperation of the maintenance department and the industrial engineering department.

One of the principal features which we wanted to bring out in our paper was the question of centralized or decentralized organizations. You may have either type you desire, or a combination of both. We merely gave this paper as a guide, for your own local conditions in many instances will determine the setup which you will have to have. Your general plant layout in many ways may govern your organization.

Mr. Hughes has mentioned the weekly meetings. I wish to place emphasis on this point, for unless weekly or otherwise regular departmental meetings are held the necessary operating information will not reach the operating men and the general results will not be satisfactory.

INSPECTION TRIP—PITTSBURGH DISTRICT SECTION

A. I. & S. E.

The members of the Pittsburgh District Section will inspect the new continuous hot and cold strip mill of the Jones & Laughlin Steel Corporation during the last week of January.

The exact date and further details of this trip will be announced shortly.

View of Jones & Laughlin Steel Corporation new continuous hot and cold strip mill.

Economic Trend

and MANAGEMENT'S JOB IN BRINGING ABOUT and MAINTAINING SATISFACTORY EMPLOYER-EMPLOYEE RELATIONS

Presented before the A. I. & S. E. Pittsburgh District Section, Friday, November 26, 1937

By GEORGE E. SOKOLSKY

▲ LADIES and gentlemen, when I was told that I was to talk at an engineering society today, I was a bit worried, because engineers are particular people, until I remembered that I was once the editor of an engineering magazine, and that I had to prepare copy for publication that had little jiggles in them and twists. Of course, I couldn't read the copy, but that is nothing. I once edited a Chinese newspaper, and I couldn't read Chinese.

I always lived in terror that some engineer would swindle me, that some engineer would bring an article that had all the little wiggles and jiggles in it that they like to draw and spend so much good money on, and that it would say something quite different from what he told me it said, and that I would find myself publishing somethin which would bring me and my magazine into disrepute, but apparently the engineers that I was dealing with in those days had more regard for getting business than they had for playing a joke, and so I survived as an editor of an engineering journal without anybody playing a practical joke on me. I suffered frightfully.

Had it been press agents or salesmen or public relations experts, like some I am looking at now, or industrial relations experts, who are even worse, I am sure that I should not have survived.

The subject I am to talk about tonight is a very unpleasant one, and really, Mr. Hughes, it is a pity to spoil a very good dinner by talking economics, but the fact is that we are in a depression. We are back again where we started. It isn't the Hoover Depression. It is a depression just the same.

Any time that steel production is down below thirty, you have a real depression. When it is below fifty you can call it a recession, if you like, but we have to change our words when we get below thirty, and steel is perilously close to that.

Therefore, we have to face altogether a different problem than I should have had to face had I come to you a month ago. Five or six weeks ago would have been still better. Then we might have been very cheerful, and we might have discussed the minor trouble of the quarrels between the steel industry and the C.I.O. Today those quarrels are unimportant because if you have no production, labor problems do not matter. Men don't quarrel about representation when there is no work, and we have to face the more serious problem of getting business, of getting orders, of finding work for men, and that is a problem which we must all consider without partisanship, without bias, and without regard to those whom we may love and those whom some of us just can't love.

CANNOT AFFORD A DEPRESSION

We can't afford a depression this year in the United States. We can't afford it. It isn't a question of who is to blame. Put the blame, if you please, on anybody. Put the blame on Mr. Oliphant, or Tommy Corcoran or Benny Cohn, or Mr. X, because it doesn't matter whom you blame. The important thing is that we cannot afford a depression. The country cannot stand the social strain of a depression before we have recovered from the last depression. The country can't afford a depression now with depleted reserves. The country can't afford the psychological effects of a depression, the discouragement, the fear, the lack of faith in the future, the lack of vision on the part of young men, the unwillingness to carry on, on the part of older men.

We simply can't afford the social and psychological effects of the depression, and we have to bear that in mind, because the depression this time must be broken

fast. It must not be allowed to take hold, and the business men of the country have got to forget who is right and who is wrong and who did it and why it was done. They have got to accept any invitation at all, the slightest invitation that might come to them from Government to cooperate in breaking the back of this depression.

GIVE THE BUSINESS MAN A CHANCE

If business in the United States is given any chance at all, any chance at all, the slightest chance, to go ahead on a business basis with some confidence that it will not suddenly be cut off by hampering legislation and childish inquisitions, business will help the President break this depression, and only business can do it.

We have tried everybody. We have tried sociologists. We have tried economists. We have tried professors. We have even tried engineers. And we are back to where we started. The time has come to try the abilities of that "dumb cluck", the business man. And the likelihood is that given half a chance he will, by the ordinary processes of buying and selling of goods, of consuming goods, of gambling on his judgment, of gambling in real estate, of doing all the silly things that business men do with money, he will pull the situation through, but it is the only way that it can be done. It is the only way that will succeed, and the job I feel for every man is to go out and use every pressure that he can bring to bear upon government, upon labor, upon the middle class, the white collar group, to support every act of legislation that will give business an opportunity to function.

Now, what is it that business needs? Why is there no confidence? Why are we in the condition that we are in?

DEPRESSION IS A POLITICAL ONE

This depression is a political depression. It isn't economic at all. It has no right to exist. We should now be talking about how we can curb a real estate boom. We should now be in the midst of a fairly active booming condition in the real estate market in every large city, and that would mean prosperity for every industry. But certain errors were made, and for those errors we are now paying.

EXCESSIVE TAXES A CONTRIBUTING INFLUENCE

The principal errors were faulty taxation, the undistributed profits tax, the capital gains tax, excessively high taxes in the upper brackets, all of which means that money is hoarded so that it doesn't earn. There is plenty of money in this country, but it doesn't pay to use it, and men don't use it. They don't expand their enterprises. They don't create new enterprises. They don't go into new efforts. They don't back new inventions. They don't back new ideas. Our entire economic life, our standard of living, our relations between employer and employee, our relations in the market place, are based upon a single conception of constant rebuilding, of constant remaking, of scrapping the obsolete and creating the new, of finding new ideas and new inventions and forcing them upon the market, and when we depart from that particular procedure, we are not functioning as we know how to function, and when men begin to deal with things they don't know anything about, they lack confidence. This psychological condition of no confidence comes out of legislation, out of politics. It does not come out of the economic condition of the United States.

LABOR IS A BIG FACTOR AT PRESENT

Another factor in that situation is labor. American industry is accustomed to paying high wages, accustomed to paying higher wages than labor receives for similar work in any other country. American industry is accustomed to decent hours. American industry is accustomed to decent working conditions. Mass production employers generally are opposed to sweating. Nobody in industry is opposed to the general principle that men have a right to air their grievances and that it is industry's duty to listen to grievances and to right them if there is any justification for righting them.

But American industry is not accustomed to hatred. It is not accustomed to bitterness. We have in the

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GEORGE E. SOKOLSKY

past had strikes that were ugly, but we have not had a prolonged period of class antagonism. We have never had such an unfair judicial body as the National Labor Relations Board. We have never had the pilloring of employers. We have never had a condition where men wonder, "Well, what is the use of going on? Why should I bear the brunt of this thing? It isn't fair. It isn't right. It is ridiculous".

UNFAIR GOVERNMENT AGENCIES CREATE CHAOS AND CONFUSION

There hasn't been a case in the steel industry during the past two years, not one single case, which involved any question of wages and hours. You can't make a distinction in the steel industry between companies that have signed a contract and companies that have not signed a contract, on the basis of wages and hours. What then is the basis for this quarrel between the employer and worker? And is the worker involved, or is it simply that a new agency is coming to industry, a political agency, that constantly keeps the country in turmoil, that constantly frightens the industrialists, that constantly makes the industrialists lose confidence in the future? That agency is a factor in the present depression, not so much the C.I.O. as the National Labor Relations Board.

I don't quarrel with the C.I.O. If they want to have a union, it is their right to have a union. I don't quarrel with their demands. If they want to make demands, they have a right to make demands. I do quarrel with a government agency which constantly is unfair, which constantly is biased and partial and oppressive, and which causes the industrialists to lose confidence in their own business and in the future of that business, and which causes the worker to be uncertain as to the outcome of the venture from which he earns a living. There is the distinction that we have to draw. One is an organization that we may not like or we may like. The other is an unfair government agency that creates chaos and confusion and has helped to bring on this depression.

INDUSTRY MUST BE ASSURED OF A FAIR CHANCE

That is what we face. It would not take very much to change the situation. If industry is relieved from excessive taxation, if industry is given an opportunity to expand, if industry is given that psychological security, so that men will feel that they are gambling in a fair field, we will come out of this depression. Business, under the capitalist system is a gamble, must be a gamble. There can be no security for the investor, there can be no security for management, there can be no guarantee against losses; there can be no guarantee against depressions; there can only be a chance that if you function according to your best judgment and are backing a sound enterprise you are likely to come out of it ahead of the game. But you must have a feeling that you are in a fair field and that if you have competitors they meet you on equal terms. Industry can't compete against competitors while it is fighting the government and while it is caught in labor troubles. That can't be done, and it isn't done, and that is why we have a depression.

LABOR AND TAX LAWS NEED MODIFIED

Our problem then is to relieve the country from unsound and inequitable taxes, and I think that will be done, but that isn't sufficient. The next problem is this—that if the Wagner Bill is to stand, and if the National Labor Relations Board is to continue, the law should be amended, and the Board's procedure should be changed so that it functions more like a court than like a political agency. The law should be amended so there is responsibility on the part of labor leaders. The law should be amended so that there is a certainty that an employer has an opportunity to present his side.

I should like to see the law amended so that an employer can file charges against the union just as the union can file charges against an employer. If we are to have a labor court, which the National Labor Relations Board is, then let it be a court of justice, not an agency of political inquisition, which it is today.

If those two things were done, and those alone, it would be sufficient. If taxes were made less burdensome and the labor situation were made clearer, fairer, more just, those two steps alone would pull us out of this depression. Those two steps are not all that we need, but those two steps alone would do the job.

CAPITALISTIC PHILOSOPHY NEEDED IN THIS COUNTRY

Fundamentally what we need is a philosophy, and this unfortunately is not a philosophic country. We call ourselves practical men and men of action, but practical men without a philosophy of life usually confuse themselves, and men of action who don't know what they are acting about are a great deal like Japanese waltzing mice, who dance around in a cage because nobody stops them.

It isn't action that we need; it is wisdom. It is experience. It is philosophy. We need thought, and what we need most in the realm of thought is clear thinking as to what this capitalist system is, and what is is to be. Business men don't like the word "capitalist". I know that sometimes when I am asked by a business organization to write a pamphlet for it and I write on the subject of capitalism, the business organization leaders take a fit. They say, "You mustn't use the word capitalism. Use the word profit system or initiative system", or some other idiotic phrase like that, something that would pass the censorship of an advertising agency.

But we do live under the capitalist system. We are capitalists. We function by investing our earnings, our accumulated earnings in enterprise, out of which we expect to make a profit, and out of which we very often net a loss. But whichever it is, that is our system; that is how we function. We have tried to move away from that system, and we have tried to have a combina-

tion of a controlled economy within capitalism, protected by a constitutional democracy, in which government officials are supposed to act as controllers.

Now, nothing can be more confused than my last sentence. When you read it, you will find that it means nothing. I am describing exactly that condition; it means nothing. You can't function a controlled economy within the capitalist system. The moment you have a controlled economy you move out of the capitalist system, you move into some other system.

OTHER SYSTEMS PRODUCE OTHER RESULTS

Human beings can live under other systems. They do live under other systems. Today more human beings in this world live under Facism than live under capitalism, and more human beings live under Communism than live in this country under capitalism. It is possible to live under the other systems; not only possible, it is being done. But would you like to do it? Would you like to live under such Facism as exists in Germany and Italy or such Communism as exists in Russia?

For instance, in Russia they are now having an election. They are going to elect a council, like our Congress, but they are doing it on a larger scale. They are going to have eleven hundred of them. We could tell them something about what it means to have a few hundred of them. But the importance of their election is that they work their ballots the way the National Labor Relations Board works its ballots. Only one candidate's name appears. Would you like to live under that system?

You see, we are forgetting that certain systems produce certain results. You can make steel under Communism. They are doing it. And you can make steel under Facism. They are doing it. But each system has its own implications. Each system has its own procedures and its own functions, and when you mix them, they won't work. If Hitler tomorrow were to introduce a democratic Congress, Germany would collapse, just as we are collapsing when controls have been placed over our economy which don't belong to our political system. You just can't do that sort of thing. That is what we are trying to do, and that is the error.

CANNOT MIX CONTROLLED ECONOMY WITH CAPITALISM

Now, I say this to you tonight in all frankness. Facing a depression, that even I, who have spent three years condemning the President and condemning his party feel this is no time to condemn anybody, but it is a time to clarify our thinking. This is no time to place blames on any shoulders, but it is a time to place heads on our own shoulders. We have not been thinking; none of us have. We have assumed that because an emergency faced us we could mix capitalism with controlled economy, that we could operate factories with an outside government agency determining wages, hours, working conditions, and therefore prices. We have assumed that we could relieve management of the procedure of operating efficiently and at the same time keep management enthusiastic about operating at all. We have assumed that we could maintain the initiative of capital and at the same time tax capital out of existence.

Those things can't happen, and whenever they are tried they bring failure. We are not suffering from a strike of capital. That is ridiculous. We are suffering from capital's lack of faith in its own future, not in the future of the country but in its own future, and lacking faith in its own future, it doesn't function. It stops acting. It ceases to be a motivating force, and therefore, we have this current depression.

INDUSTRY HAS MADE MISTAKES

During the last depression industry made a great many mistakes. One of the most serious mistakes that industry made was indiscriminate laying off of workers. Industry lost the finest skilled workers that the country had during that period. And you remember last winter, when we thought we were in a boom, there was a shortage here and in every industrial city of skilled workers.

Every company will have to lay off men during the next few months. No company will be able to avoid layoffs. And companies should, therefore, immediately form policies which will not result in as much hard feeling, in as much hatred, in as much ill will, as the last depression engendered. For instance, those companies which have contracts providing for seniority rating and layoffs are stuck, because skilled workers should be protected against unskilled workers. The foundation of industrial relations must be the skilled worker. The skilled worker must be given first protection to stimulate a desire on the part of men to become skilled workers. The sacrifice of the skilled worker in the last depression left the industrialist without his natural partner. Instead of having men in his plant who were old workers, who had served the company long, who had been faithful, who had a tradition in company relationships, they laid off indiscriminately, and took in a lot of young fellows, and the young fellows became their enemies because the young fellows had no tradition in industry, no traditional relationship with the company.

I think that is a question which is fundamental in our present situation. Men should be saved on the basis of their value to industry, and not on the basis of their seniority, because in many plants today seniority means that the man was taken on two years ago. Skill should be rewarded as much as possible, and the skilled man should be protected as much as possible, and the faithful man should be protected as much as possible, because the faithful man sacrifices himself socially very often in the interest of his industry, and when a period of layoff comes, he should be protected.

INDUSTRY SHOULD HAVE CONFIDENCE IN FUTURE

There is one other thing that industry ought to remember, and that is that this is not the end of the world, nor is it the end of our country. Too many industrialists whom I meet today have become hard-boiled. They take the attitude—What the hell? These fellows gave us a hard time during the past two years, and we will just do what we have to do. That is a short-sighted attitude. It is as short-signted as the attitude of the employer who says that we tried to be fair and just during the depression and as soon as good times came we were kicked all over the lot. That also is short-sighted.

We are not going to be in this condition of conflict always. We had to learn a lesson. All our troubles go back to the War. Now we know that war profits are net losses. Then we marched into the Coolidge boom and every man was a millionaire. Everybody was on the market. Everybody was buying stocks. We have learned that when everybody is a millionaire it isn't long before everybody goes broke.

Then we went into the depression and we all became glum. We were all selling the country short, and we all believed the capitalist system was rotten, and we threw Hoover out. Not the worker threw him out, all of us threw him out. I didn't vote for Hoover in '32. Neither did most of you. We took on a new system and a new idea, and we said, "We will work the new way now". Don't blame it on Felix Frankfurter. They all went down to Washington at the beginning, all the great men, our bosses. Everybody was going to be in this new thing.

GO BACK TO THE SYSTEM RESPONSIBLE FOR OUR GREAT DEVELOPMENTS

Now we have learned that this new system doesn't work. We are beginning to learn, if you have to go back to the Bible, that Joseph understood more economics in one dream than the whole Brain Trust and Columbia and Harvard Universities have understood during the past five years. The seven lean calves consumed the seven fatted calves.

When I was a boy I had to learn that, and I was always sure the printer made a mistake. I always felt that it was the seven fatted calves that consumed the seven lean calves. But Joseph was right.

We have to go back to a psychology of thrift. We have to go back to family life. We have to go back to a sense of national patriotism. We have to go back to a sense of social responsibility that doesn't involve giving a man $14 a week on relief, but that does involve finding work for a man and getting a decent day's work for a decent day's compensation. We have got to expect that there will be periods of intense prosperity, and that there will be periods of considerable economic suffering, and we have got to set up reserves to meet that.

You see, it isn't blaming one man, or blaming one group of men, that helps us to think clearly. A whole nation drunk with war prosperity, and for that matter in the throes of Prohibition, developed a new economy, a new philosophy of life. The sky is the limit. You don't need to save. You don't need to be prepared for a rainy day. Copy-book adages are nonsense. Spend, spend until you are mad. Create businesses that exist on the theory of spending more than is earned. Stimulate advertising. A false conception of the relationship of man to man, until, why should a worker not want a hundred dollars or a thousand dollars a day? And what does that mean in terms of real money or of a living standard?

We have got to go back. We have to go far back. I don't say, Go forward. If we go forward on the road that we are walking on, we will move into an abyss. I say, Go backward. Go backward far to an economic system and a political system which after all for a hundred years gave our money stability, gave us peace, gave us the most wide-spread diffusion of wealth known to man, gave us an increase in human comforts, which no thousand years in the history of man achieved, opened us to every form of human freedom, ended class distinctions, ended religious prejudices, gave us freedom of speech and of the press, and all that was based upon an economic system which made it possible for the individual man to do what he pleased with his own earnings.

That is what we have to go back to, and we have got to go back to it fast. Under that system the worker was free, and when I say the worker was free, I say something that this generation doesn't understand, because this generation is flabby with freedom. It has had too much freedom.

FREEDOM SHOULD BE RESTORED IN THIS COUNTRY

The other day I was talking to some women in Albany, New York, at the Federation of Women's Clubs, and there was a letter there from a woman whom they told me was one hundred years old. She had been attending meetings of the Federation for forty or fifty years, but she couldn't come the night that I was to talk, because for the first time she was physically unable to, and so she wrote a letter to tell these women what they ought to do. The chairman of the meeting rose and read the letter. When she was through reading there was applause but I felt that nobody had quite heard the letter.

As I was sitting next to the chairlady and did hear the letter, I threw away in my own mind the speech which I had planned to deliver, and I picked up her letter, and using her letter as a text, I explained the meaning of her letter.

The last phrase of the paragraph in which she instructed her women what to do contained this: "For the restoration of American freedom". She didn't use the word "preservation", nor did she use the word "continuance", but she used the word "restoration", and I reminded those young women who were there that in 1836, when that woman was born, there was practically no place on earth where men really had freedom, except in Great Britain and in this country; that in 1848, when she was twelve years old, throughout

Europe there were revolutions for the type of freedom that we take as a matter of course today; and that the European worker was fighting then for freedom, for political freedom, which he didn't have and which in many countries he didn't get; that she was a young girl getting married when the serfs were freed in Russia and slavery was abolished in the United States, the last step in establishing the political freedom of the worker; that during her lifetime this conception of human freedom spread from this little country, England, where it was conceived, to our continent, then to France, then even to the central powers, then to Eastern Europe; that she had seen that spread.

HUMAN RIGHTS AND LIBERTY WERE HARD TO ATTAIN

Human rights and human liberty were not a matter of course to her because in the century that she had lived, she had known when it was lacking. She had known when it was rare. And she has lived a century, and the cycle has come back, and now this sense of human rights and of freedom under the law, this assurance of it, is beginning to disappear. The last European countries to get it were the first countries to give it up—Russia, Germany, Italy.

Can you imagine, some of you—Mr. Friedlander here, do you remember Garabaldi– His country is no longer free, but you have to be as old as Mr. Friedlander to remember Garabaldi. The young people don't remember how hard it was to win this liberty, and the cost at which it was won. And the interesting fact is that human rights today only exist in those countries where the capitalist system persists, England, the United States, the Scandinavian countries, Holland, Switzerland, and perhaps France. In all those other large and important countries human rights have disappeared and capitalism is disappearing, and capitalism disappears as soon as human rights disappears.

A Facist country is not a capitalist country; it is a collectivist country, because in a Facist country the government controls the means of production and distribution, controls wages and hours and prices and quotas of production, and the worker becomes a slave to a government controlled labor union.

WORKERS AND MANAGEMENT MUST UNITE

The worker of this country has got to join with management in saving himself from that peril, and he will, because he is beginning to understand his peril. Who is attacking the National Labor Relations Board more virulently today than the American Federation of Labor? They have discovered what government-controlled production can do to the worker. In this country, as in Germany, it was the skilled worker who was curbed first, and the skilled worker in the A. F. of L. has discovered the menace of government controls of labor unions, because that after all is what this board is, a government control of labor unions, a government control eventually, not so much of management as of the worker himself.

Management must be patient in this crisis. Management must be understanding. Management has had advantages which the average worker hasn't had. Management must seek among the workers allies, allies of understanding, allies who will fight alongside of management for the maintenance of a sound capitalistic economy in this country, and management will find among the workers such allies. Management already is finding among the workers such allies.

WORKING MAN HAS BEEN DECEIVED

I wish at this point to call your attention to Homer Martin's activities in Detroit during the past week. I regard that as one of the most significant events in the current labor movement. Here is a man who conducted the worst strike in this country, from the standpoint of decency and fairness and justice. He took a company that paid the highest wages and gave the best working conditions and practically routed it without any justification, and now he finds himself faced with the same troubles that they faced when he fought them. He doesn't want to change the capitalist system. He doesn't want to destroy industry. He doesn't want to make industry government controlled. He would like to function on the basis of contractural relations, and he finds that he must defend management in a situation where management is right and those who want to change our economy are wrong.

Do you think that a year ago Homer Martin would have taken the stand that he takes today? Do you think a year ago the A. F. of L. would be opposing the Wages and Hours Bill? Why the change? The change comes because the working man, the skilled worker, the normal American worker, is beginning to discover that he has been misled, that he has been tricked. He showed it in the election in Detroit. He showed it in the election in Akron and Canton. He is showing it in every attitude that he takes today, and the leaders are beginning to respond to it.

GOVERNMENT MUST GIVE CAPITALISTIC SYSTEM CHANCE TO WORK

I am not pessimistic about employer-employee relations. They will work out. I am pessimistic about our thinking clearly, about our determination that controlled economy will not function in a capitalistic state, and that if we want a capitalistic economy, government must release the controls. I don't say, no regulation. Regulation and control are different. Government must release the controls, and if this government that we now have releases the controls and gives our economic system a chance to work, our present depression will simply be a bad two or three months. If it doesn't, we are going to sink back into a depression that will make '29 to '32 look like a pleasant interval.

The question is one of the brakes. Will government take its foot off the brake? If it does, we go ahead. If it doesn't, we can't stand still. That is the problem

that faces the whole country. I think that if we all become politically minded, if we all bring pressures to bear, if we all exercise ourselves over this question, the foot will come off the brake. Nobody wants to destroy the United States. Nobody wants to destroy our economy. Nobody wants to bring poverty and hunger and suffering again in this country over a winter, but too few of us remember that in a democracy Government only responds to pressures, and that it is the function of every citizen to bring pressure upon government. The pressure today must be revised taxation, and take the sting out of the National Labor Relations Board. Those two things, and we are out of the depression. Thank you.

The Author

George E. Sokolsky, noted author and lecturer, has gained international attention through his articles on the Far East and Europe. He was away from the United States for fourteen years, returning to this country in the second year of the depression. This afforded Mr. Sokolsky an opportunity to study the economic problems of the United States objectively, as he would any foreign government. As a part of his study he has traveled more than 100,000 miles in our country visiting nearly every state. During the summer of 1933 he went to London to observe the Economic Conference and to analyze the economic and political position of the United States in relation to the rest of the world. So profound have been his conclusions that the Atlantic Monthly, American Magazine, Esquire, American Mercury, Vanity Fair, and several other publications have printed numerous articles by Mr. Sokolsky, in this field.

Reprints

We wish to announce that there are available a quantity of George E. Sokolsky's speech on: "Economic Trend, and Management's Job in Bringing About and Maintaining Satisfactory Employer-Employee Relations".

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1010 EMPIRE BUILDING
PITTSBURGH, PENNA.

Symposium

FLOOD PROTECTION AND REHABILITATION

PROTECTION AND REHABILITATION

E. A. HESTER
Duquesne Light Company
Pittsburgh, Penna.

and

ROBERT CRANSON
West Penn Power Company
Pittsburgh, Penna.

RECONDITIONING FLOOD DAMAGED INDUSTRIAL ELECTRICAL APPARATUS

F. S. WHITE
Westinghouse Electric & Mfg. Co.
East Pittsburgh, Penna.

and

GEORGE P. AIRHART
General Electric Co.
Schenectady, N. Y.

DISCUSSION PRESENTED BY

G. R. CARROLL, Electrical Superintendent, Jones & Laughlin Steel Corp., Aliquippa, Pa.

T. J. FLAHERTY, Electrical Superintendent, American Rolling Mill Co., Ashland, Kentucky.

J. C. DAVIDSON, Standard Underground Cable Company Div., General Cable Corporation, Pittsburgh, Pennsylvania.

J. J. BOOTH, Asst. Chief Main. Engr, Carnegie-Illinois Steel Corporation, Duquesne, Pa.

JOHN KASPARI, Assistant Electrical Engineer, Weirton Steel Company, Weirton, West Virginia.

J. J. DURKIN, Service Department, General Electric Co., Pittsburgh, Pa.

T. E. HUGHES, Chief Maintenance Engineer, Carnegie-Illinois Steel Corp., Duquesne, Pa.

J. S. MURRAY, Chief Electrical Engineer, Follansbee Brothers Co., Follansbee, West Va.

L. F. COFFIN, Supt. Mech. Dept., Bethlehem Steel Company, Sparrows Point, Md.

N. C. GOIN, Sales Department, Westinghouse Electric & Manufacturing Company, Pittsburgh, Pennsylvania.

JAMES FARRINGTON, Electrical Superintendent, Wheeling Steel Corp., Steubenville, Ohio.

WRAY DUDLEY, Electrical Superintendent, National Tube Company, McKeesport, Pa.

FLOOD PROTECTION and

Presented before the A. I. & S. E.
Pittsburgh District Section
June 23, 1937

▲ THE great flood of March, 1936, focused attention on the need for flood protection of plant and property. It was a convincing demonstration that utilities and their customers must be ready to protect equipment against unpredicted floods, in order to prevent serious damage and shutdowns. Considerable experience was gained from the flood in methods of rehabilitation and the procedure to follow in reconditioning equipment and restoring service.

When the first signs indicated that a flood was imminent the ordinary precautions were taken. But no one had any idea that the water would reach a stage sufficient to shut down the power stations, as they had been designed to operate under as severe or worse flood conditions than had ever been experienced. When it was obvious that this flood was to be of extraordinary proportions, it was too late to prevent serious damage. Neither the utilities, industrial plants, or the community as a whole had anticipated such a catastrophe.

On Tuesday, March 17th, the Weather Bureau predicted a crest of 33 feet for Pittsburgh which was changed to 36 or 37 feet that evening. At 11:00 P.M. another prediction of 38 or 39 feet was made, and at 3:00 A.M. the next morning 40 feet was predicted. But the maximum crest was 46.2 feet.

As soon as it was seen that, at a number of substations, the high tension breakers would be flooded and made inoperative, they were either opened, blocked closed or entirely disconnected, depending on the system operating plan for the emergency in that particular area.

The West Penn System, which is scattered over sixteen counties of Western Pennsylvania, began to note trouble from the rising waters early on the morning of March 17th when the Clarion, Red Bank, Chartiers, Loyalhanna, Youghiogheny, Kiskiminetas, and Allegheny Rivers left their banks and rose far beyond previous high levels. The Connellsville Power Station on the Youghiogheny River escaped being flooded out by inches due to the untiring efforts of the employees. The Clarion River flooded the Ridgway Station and at the same time the worst sleet storm ever known in the Ridgway-St. Marys District broke down miles of electric and telephone lines. High and low tension stations at Latrobe, Youngwood, Apollo, Vandergrift, Freeport, Brackenridge, Kittanning, New Bethlehem were all in serious trouble, some escaping with minor damage and others requiring complete rehabilitation. The Springdale Power Station, built to operate at 6.7 feet above previous record high water, was filled to a height of 2 feet above the turbine room floor.

It was fortunate that the joint station of the West Penn System and the American Gas and Electric Company at Windsor was able to operate continuously during the emergency. The American Gas and Electric Company not only supplied as much power as possible to the West Penn System, but it stood by to render any other assistance on call. The Windsor Station continued in service even though its 11 Kv. cable tunnels were filled with water and even though the water in the high tension switchyard took the proportions of a large lake, extending from the hills of West Virginia on one side to the hills of Ohio on the other side and as far north and south as one could see. But even with all of this water, the station could have survived a 2 foot higher water level without being in serious difficulty.

At about the 37 foot stage, Tuesday evening, March 17, 1936, many Duquesne Light Company customers along the rivers reported damage to equipment and

PITTSBURGH'S GOLDEN TRIANGLE INUNDATED BY 46.2 FEET OF

and REHABILITATION

By
E. A. HESTER *and*
ROBERT CRANSON

requested that service be discontinued. When the water rose to the 40 foot stage, which was 6.4 feet higher than the previous disastrous flood of March 28, 1913, it was impossible to prevent damage, especially in view of the sustained nature of the flood. A shutdown of the equipment was therefore inevitable. Water filtered into the basement of the Colfax Power Station and reached the generator air ducts. It also reached the cable potheads in the basement of the switchhouse of the Brunot Island Plant. It flooded generator leads of the old Brunot Island Power Station it toppled over a 66,000 volt river crossing tower, thus opening the high tension ring of the Duquesne Light Company. It finally submerged the equipment in the basement at Colfax and the 11 Kv. cable tunnels of the Reed Switchhouse. It also covered the switchyards at Brunot Island and Colfax and the heavy debris and large objects that floated down the river knocked down poles and damaged overhead lines. It inundated many substations and the water soaked much of the rotating and stationery equipment. It flooded many high and low tension customer substations and damaged the wiring in the basements of most buildings wherever the water poured in. It submerged most of the downtown vaults and equipment. It damaged underground company telephone cables and all but shut down the telephone system. It rendered the two steam heating plants in Pittsburgh useless because of the flooding of the steam tunnels and customers' premises. So much damage was done in so many parts that an equipment shutdown was not only impossible to prevent, but the task of restoring equipment to operation at first looked almost hopeless.

As soon as it was evident that the flood would badly damage the equipment and that replacements would be necessary, the management decided immediately to secure as much new equipment, cable, and wire as it could on short notice. Consequently an organization was set up which determined the ratings and type of equipment and cable which would be needed, and other utilities and manufacturers were contacted in order to secure it at the earliest moment. New testing equipment was needed because practically all of the Duquesne Light Company testing facilities were rendered useless by the water. Within 10 hours, therefore, after the shutdown, two carloads of special equipment were enroute on special trains from the New York Edison and the Philadelphia Electric Companies. Orders were also placed for more than $2,000,000 worth of wire, lead-covered cables, meters, and other items. Much of this equipment was on the way to Pittsburgh even before the water had fully subsided. Some of it was shipped on trains, some on trucks, and some of it by airplane.

After the shutdown the first thoughts were to plan how to proceed with rehabilitation. But in order to pump and clean up, power was necessary. As it happened, the Duquesne Light Company was never without power. Fortunately, it was possible to obtain some energy from a 22 Kv. tie line from the West Penn Power Company at McKeesport. It was not only imperative to have power for pumping operations, but hospitals, the telephone company, and other essentials had to be served. Negotiations for a supply of energy were immediately started with other utilities. It was not long before power was being received from several sources. By Thursday noon, or approximately 20 hours after the shutdown of the Duquesne Light Company plants, the company was receiving 20,000 Kw. of energy from

WATER AT THE CREST OF THE GREAT FLOOD OF 1936

neighboring utilities and private plants. It is interesting to note that in order to use this power, it was necessary to break the system up into seven independent units, none of which could be paralleled at that time due to different voltage conditions. Power was, therefore, available to supply first priority customers and for rehabilitation work.

But even though the West Penn System was able to operate continuously because of the Windsor Station and the interconnection with the American Gas and Electric System, the loss of the Springdale Power Station was a serious handicap. Another serious loss was the shutdown of the Vandergrift Substation. This substation furnishes an important scattered light and power load of 10,000 Kw. over an area south of Leechburg to north of Apollo. Several river crossing lines also failed. Water and mud put the 25 Kv. switching stations at Freeport, Allegheny Steel, Apollo, as well as the Springdale 132 Kv. oil circuit breakers, out of service. At the Springdale Power Station many important motors were below the turbine room floor and were flooded. The main generator leads and about one-fifth of the windings of the units were also water soaked. The story of the West Penn and Duquesne Light systems was much the same—water and mud—a major job of reconditioning damaged apparatus and the reconstruction of a damaged transmission and distribution system.

The removal and drainage of water and the cleaning up of mud and bebris was a tremendous job. In this work the operating departments used construction men, office men, and many temporary employes. And where water went in, mud went in too. This mud was deposited everywhere. It covered walls, floors, buses, wires, meters, switches; it got inside of motors and in other rotating machinery; it covered floors in some places several inches thick. Besides this, water entered such equipment as transformers and oil circuit breakers and forced the oil out. The electrical buses, meters, rotating equipment, wires, and other electrical apparatus were, therefore, not only saturated with water, but were covered with mud, and some of the equipment was covered with mud and oil.

The first job was to pump the water out. As many stationary gasoline pumps as it was possible to procure were set up and assistance was rendered by fire departments of the city and neighboring boroughs. It took a day and a half to dewater Colfax, and shorter periods for smaller stations. In some parts of the downtown district in Pittsburgh it was not possible to dewater until the river went down, as the water came in as fast as it was taken out. The outlet valves of those transformers that were inundated and which had taken in water were opened and drained during the dewatering process.

As soon as the water would permit, crews were organized on a 24-hour basis to clean up the various substations and distribution vaults. They were also organized in the power stations to wash, scrub, and clean every piece of equipment of water and mud. This was a tremendous job. The power stations were scrubbed from one end to the other, 15 fire hoses being used at Colfax. Little damage was done to the James H. Reed Station of the Duquesne Light Company, although the Brunot Island Plant suffered a great deal. But due to damage to generator leads, more time was taken at the Brunot Island Plant, and it was necessary to do work on the potheads in the Brunot Island switchhouse before the James H. Reed Station could operate. Work was, therefore, concentrated in getting Colfax and the distribution system back into service immediately. After the water had gone back to the river the rehabilitation crews cleaned up the substations, power stations, the vaults, and the electrical wiring and equipment preparatory to new replacements or the reinstalling of the same equipment after it had been dried out.

With so much equipment in a disabled condition, it was a major problem to quickly restore it to operating shape in order that service could be resumed at the earliest moment. How much equipment should be removed and dried out and how much could be dried in place? When dried out should it be immediately replaced and left in place, or should a more thorough drying be given later? These questions had to be answered.

The policy which the companies adopted was a combination of these alternatives. Some equipment was dried out in place, some was disconnected and dried out on the job; other equipment was taken to central drying ovens and reconditioned there. Much depended on what it was and how much damage had been done. In a number of cases rotary machines were dried out on the job, but the smaller machines which were easy to move were taken to the central ovens. If duplicate equipment was in stock, such as meters, or transformers, the damaged pieces were removed and replaced with stock items. In some places it was necessary to rewire or replace damaged wires and cables, particularly the older installations and the unleaded paper insulated cables which were in existence in some parts. In order to replace such items as meters and relays or other equipment which was damaged beyond repair in the field, orders were immediately placed with manufacturers for new pieces. Each location had to be examined and the policy adopted so far as replacements or drying out were concerned, either on or off the job, depended on the type of installation and how badly it was damaged.

The equipment was dried out in a number of different ways. Some was sent to manufacturers' plants, but the majority was dried out in the ovens set up by the company. The Duquesne Light Company built six drying ovens at its Manchester Shops, five of which were in canvas enclosures heated by forced draft steam radiators. The sandblast room at Manchester was used for a sixth oven and steam radiators were installed there. In other parts of the Duquesne Light Company system, in substations and on customers' premises, small drying ovens were set up where the smaller size equipment such as small motors, small transformers, and other various types were reconditioned. Strip heaters, salamanders, and steam coils were used in these places, whichever was most readily available and convenient. Some of the induction regulators were shipped to plants of the nearby manufacturers and others were dried out at Manchester, together with the auxiliary equipment such as current transformers, potential transformers, compensators, contact making voltmeters, and

resistors. A few large rotating machines were dried out in place by building canvas enclosures over the machines and by blowing heat through them. Blow torches were used to dry out wiring by holding the torch close enough to evaporate moisture. Almost every possible way to apply heat was utilized, externally and internally. Some equipment was left to dry in the air. In some places ovens were made out of oil circuit breaker tanks to which heat was applied. When there was little danger of damage, machines were excited and operated on short circuit at a low voltage in order to assist the drying process. On the Duquesne Light Company system up to 18,000 pieces of equipment were reconditioned, among which were many large pump motors, transformers for power and light, and regulators.

Many difficulties were encountered in getting the electrical equipment back in service. The large generators were not damaged to any great extent and were dried out in place. But the transformers in vaults and other places offered considerable difficulties. Many of them were located in sub-basements and in inaccessible places. They are very heavy, many of the vault transformers weighing around 7 tons each. Special heavy duty trucks manned by competent riggers were necessary to remove them and much ingenuity and careful work was necessary to prevent damage and to prevent accidents. Many potheads that were submerged while energized blew up and had to be replaced. Those which were under water and were still in good condition were cleaned out, dried, refilled and retaped. Most of the motors responded to drying treatment after the mud had been washed out of them. In drying out the D.C. machines considerable trouble was experienced in some places with the commutators. It was difficult to get the moisture out of the V rings and it was found that the best way to remove this water was by loosening the commutator assembly. The exposed wiring on the switchboards and the terminals were cleaned by hand wiping and the air gradually dried them but the wires in conduits presented a problem. Some of them had to be replaced but generally speaking it was found that compressed air through the pipes was the most effective remedy. Considerable difficulty was experienced with grounds on the control wires and in many cases new wires were necessary. Circuit breakers were dismantled, thoroughly cleaned and the operating coils dried out. Many of them, whose bushings were under water, were retaped at the bushings. Relays and meters were a major problem. Not only was it extremely difficult to get into cellars where meters were installed on customers services in order to disconnect and clean the meters, but the cellars all had more or less water, mud, and debris in them. The task was made more difficult by the size of the job. On the Duquesne Light Company system alone, 14,950 meters were reconditioned in the shops and 13,264 meters were replaced. Every meter fit to recondition was disassembled and every part cleaned, dried, and tested, and the whole reassembled.

On the West Penn System, about 500 motors ranging from fractional horsepower to 600 horsepower were removed, cleaned and dried out in ovens of nearby manufacturers. The railway motor generator sets were dried in place. Crane service normally supplied from the Railway sets was obtained by connecting two sets of batteries in series. The main leads of the three main units which had been under water were dried out in place and the main generator windings were reconditioned by short circuiting the windings and by applying sufficient voltage to produce approximately full load current on the machine. Hot air was then blown through the air ducts to get rid of moisture driven off by the internal heat. During the process the temperatures of the windings were watched and megohm readings were made at frequent intervals.

The operating forces of the companies learned a great deal about cleaning and drying out equipment from the flood experience. For instance, it was found that the best way to clean the mud out of a badly soaked machine was to wash it with a high pressure hose, being careful not to injure the insulation. The better the initial cleaning, the better the final job. It was found that grease and oil could be removed with gasoline, without damaging the wet insulation. Some particles hard to get off could be removed with a fibre brush if one was attentive to insulated parts, for soaked insulation is very easy to injure. It was found essential to free all ventilating ducts of clogging materials and the compressed air hose was a good tool for this purpose. Experience showed that laminations could best be cleaned with a stiff brush. After cleaning as thoroughly as possible, an inspection was found highly essential because it was found that fibre or wood wedges had a tendency to warp and some of them had to be replaced.

The experiences in reconditioning the equipment, suggested possibilities for improvement in future designs by the manufacturers in order to eliminate the annoyance and interruptions caused by the smaller items. Certain types of fibre used as an insulating material in auxiliary relays warp and swell after being wet and dried. Certain metal parts, even though thoroughly cleaned and oiled, and which were apparently dry, later showed signs of rust, thus causing friction. The result was a sluggish operation or no operation when called on to perform. As it is practically impossible to obtain these parts quickly at the time of a flood, and since it is not economical to carry them in stock, one was forced to use them at least temporarily. It would be better if non-hydroscopic insulating materials and non-corrosive metals were used in the vital parts of various relays and mechanisms.

But in drying out machines it was found that it was best to have an efficient method of removing moisture while applying heat, and that the drying out process could be speeded up by running the equipment on short circuit, if this were possible, thereby providing internal heat that drove the moisture out from within. In removing moisture, ventilation was a major requirement. As an example, it was found that one of the most effective ways of drying large outdoor transformers was to blow hot air in at the bottom through the oil discharge valve and take it out at the top of the case, thence to a lime box to remove the moisture and through the blower again and back to the transformer. Together with low voltage on one winding with the other short circuited to provide internal heat, this method did a very good job. One

thing had to be watched, however, in applying external heat—it was desirable not to overheat because of the danger to windings. About 185° F. is a good limit for materials such as cotton, linen, and paper and not more than 200° to 205° F. for mica and asbestos insulation. A machine in a closed chamber, however, without ventilation will dry very slowly. The best method is the vacuum oven, although a well-ventilated oven did a very good job. It was found that blowing heat through a rotating machine worked very well. In this way, moisture was carried away while the incoming air dried the windings. If a machine could not be rotated it was found helpful to turn the stator over 180° occasionally. But in applying voltage to a machine, it was necessary to be careful and wait until at least 50,000–60,000 ohms insulation resistance had been reached for several hours with the machine heated up and, after applying voltage, to watch the windings for hot spots. The internal heat of the machine then dried the windings from the inside out and a much better and quicker job was possible.

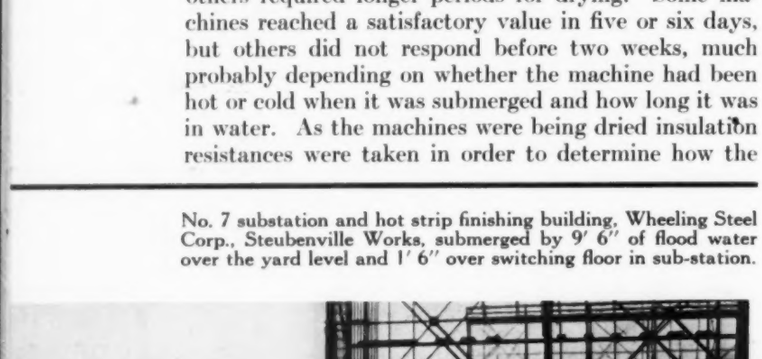
On the Duquesne Light Company system some of the equipment reconditioned and overhauled consisted of 655 motors, 503 transformers, 744 switches, starters, and controllers, 16 generator field rheostats, 514 circuit breakers, 14,950 meters, 1,552 bearings, 250 trip or closing coils, 3 synchronous condensers, 26 induction regulators, 8 main generators, 65 potential transformers, and 280 current transformers. Twenty-five motors were rewound and large quantities of cable and wire were replaced, both inside and outside the plants.

When reconditioning electrical equipment, megohm tests were necessary to determine the resistance to metal parts. Some machines would come up to a reasonable insulation value within a short time, while others required longer periods for drying. Some machines reached a satisfactory value in five or six days, but others did not respond before two weeks, much probably depending on whether the machine had been hot or cold when it was submerged and how long it was in water. As the machines were being dried insulation resistances were taken in order to determine how the drying was progressing. It is well known that insulation resistances decrease in value as the temperatures increase. It was found, therefore, that sharp decreases in resistance took place when heat was first applied. Even after the machines had been dried and insulation resistances had risen to near normal values, this was not always an indication that a machine was completely ready for service. It was possible that some of the turns of field coils might have become short circuited between turns. If the drop across these coils or other similar windings indicated that all like coils had similar resistances, this was taken as a fair indication that the machine was not damaged internally and could be put back in service. After the cleaning, drying, and testing, and in as many cases as time allowed, two or three coats of air drying varnish were given to all insulated parts. In some cases machines or coils were baked again after they were varnished. Before any equipment was returned to service on the West Penn System, it was given the standard potential test for at least three minutes after it had shown a satisfactory megger test.

Open Hearth and Water Works, Wheeling Steel Corp., Steubenville Works showing water at its highest level.

As a result of the St. Patrick's Day flood of 1936, changes are being made at the Springdale station of the West Penn System which will permit it to operate with a river having a stage 6 feet higher than that reached March 18, 1936. All the generator leads have been raised above any probable flood level and have been placed on insulators. All doors have been equipped with bulkheads. All basement windows have been closed with reinforced concrete and the walls around the air intakes of the generators have been raised and strengthened. All pipe openings through walls have been sealed with gaskets. The temporary wall across the South end of the main building was of a temporary nature. It was not waterproof and was not strong enough to withstand the water pressure during a flood. This has now been changed so as to provide a reinforced concrete wall bonded to the permanent walls with sufficient bracing to stand flood pressure. As an additional precaution, five new sump pumps with a total capacity of 20,000 gallons per minute are being installed. The walls of the hoist house mine shaft are also being raised to protect them to the level of the plant proper. All the switchboards and the control

No. 7 substation and hot strip finishing building, Wheeling Steel Corp., Steubenville Works, submerged by 9′ 6″ of flood water over the yard level and 1′ 6″ over switching floor in sub-station.



60″ mill and finishing building, Wheeling Steel Corp., Steubenville Works, showing flood waters at their crest.

equipment has been moved to a higher level. A barricade has been erected across the property upstream from the station to deflect debris. This debris did a great deal of damage during the 1936 flood. High tension lines in this area have been arranged so that quick sectionalizing can be done during a future emergency. In the Vandergrift area a small substation is being built which will take care of most of the load in case the Vandergrift Substation should ever be flooded again.

The experience learned from the 1936 flood is that the plants had not been designed for maximum flood heights and that it would be impractical in every case to protect against such catastrophes. Also if new plants or additions are contemplated, flood protection must be carefully considered. For instance, every important piece of equipment such as pumps and the electrical equipment that are necessary for continuous operation must, if possible, be so located or of such design that high water will not shut them down. Where possible they should be set up on higher levels, or if this is not possible, an attempt must be made to keep the water out. Sump pumps and water pumps must be selected and arranged so that continuous operation under flood conditions is possible. Electrical equipment in the yards and in places subject to floods must be made either water-tight, or must be guarded against water. Supplementary or auxiliary equipment may be installed above high water levels in important feed areas and at important customer locations such as telephone companies, hospitals, water companies, etc. Equipment in underground vaults must be water tight. Important lines and substations must be capable of operating under high water conditions or a method of isolating them with alternate feeds should be provided for.

Specifically, the experience suggested that all buildings of importance in the flooded areas should be equipped with bulkheads and that a study should be made of the pumping situation in order to first keep most of the water out and second, to remove the water that gets in. If this were efficiently done, little difficulty will be suffered at the plants and substations. This is not always possible because of water seepage through openings in walls and floors, and when excessive leakage takes place during a flood, immediate consideration must be given to saving equipment from damage. The outside plant, particularly, is susceptible to damage from large floating obstacles that go down the river during floods and do much damage to pole lines and towers in the vicinity of the rivers. This sort of damage is very difficult to combat because most of these structures cannot be moved to higher locations. Alternate feeds through system ties which are usually present in the larger electrical systems, will go far towards eliminating complete shutdowns. The experience with the substations on the customers' premises indicated that much of the equipment that belonged to the customer was as vulnerable as that of the company-owned plant. If the customers' plants were down, he was just as badly off as though the service itself were down. Customers, therefore, have found it desirable to protect by walls, or by the lifting of equipment to higher levels, or by the use of bulkheads. Some have installed an auxiliary station on a level above maximum flood stages. Since potheads are particularly vulnerable to water, the experience indicated that every pothead that was subject to being flooded should be raised above the probable flood stage and should be of the waterproof type so that if they were flooded, water would not get into the cables and ruin them. Possibly bulkheads and the pumps will do as much as anything in the future in protecting against floods, at least while everyone is still flood conscious and keep flood protection equipment in shape for immediate use.

When a flood is in sight, therefore, it is very important to immediately set up and bolt on the bulkheads and to caulk and close up every known opening against the expected water. Pumps should also be tested and put into operating condition. If the expectation is realized and if then it becomes apparent that the bulkheads and pumps cannot keep the water down, the motors and other damageable equipment should be removed and lifted to higher levels, until the danger is over. The parts of a system which are in danger or which are not waterproof and which are subject to submersion should be disconnected from service in order not to destroy

Cafeteria and hot strip mill buildings, Wheeling Steel Corp., Steubenville Works partly inundated by flood waters.

the equipment by operating it under water. If these precautions are taken, service to many parts can be continued and the equipment that becomes wet can be reconditioned and made serviceable again. It is also a good investment to have one or two permanent ovens set up in a central place for an emergency. Undoubtedly use can be made of them during so-called peaceful times for the impregnation of electrical equipment that has been rewound or repaired.

The reconnection of the customers, particularly the low tension customers on the Duquesne Light Company system, was a rather difficult task after the flood of 1936. It held up the restoration of service to many people, for the regular power service was available before it was possible to finish the reconditioning of large numbers of buildings. The difficulty was that the building services were water soaked and because of the age and type of wiring, many of the owners were forced to completely rewire. The inspectors of the City would not approve a great many of the services and it was a number of weeks before these buildings could be reconnected. The company assisted building owners and inspectors as much as possible by supplying skilled wiremen and engineers who tested and assisted in removing damaged parts and who expedited the return to normal service.

Immediately after the Duquesne Light Company system had been shut down, a priority list of customers was approved and these customers were returned to service in the order of importance as quickly as possible. Fortunately, it was only a matter of hours when the first priority customers received service. The order of restoration was: (1) Communication—police and fire systems—telephone; (2) Water pumping, hospitals, dairies, bakeries; (3) Street service—street lights and street cars; (4) Commercial lighting and power; and, (5) Industrial customers.

No discussion of this subject would be complete without mention of the neighboring power companies who stood by faithfully and rendred assistance when they themselves were stricken. They and their customers sacrificed service to assist those who were in greater trouble than themselves. The help rendered by these companies in supplying power and the assistance rendered by those companies who sent spare equipment over the road was of incalculable value to the striken systems. And none should lose sight of the fact that the primary reason that service was restored so quickly was because of the persistent and untiring effort of the personnel of the companies involved. Despite the danger of disconnecting equipment under water and the hazard in removing and replacing so much heavy apparatus, no serious accidents were reported. But the lessons learned from the experience has indicated the need for efficient flood protection and the recent flood which devastated the Ohio Valley will probably not go by without a greater demand for central flood protection. The communities along the rivers in the Tri-State area will never be safe without flood control, but the experience has convinced the power companies and their customers of the necessity of protecting their plants by every possible means and when new plants are added, to design them to operate under high water conditions.

RECONDITIONING

By

F. S. WHITE *and*
GEORGE P. AIRHART

▲ WITH the recession of the flood waters which reached their crest at Pittsburgh, March 18, 1936, all power companies as well as industrial companies, in the flooded area, were confronted with the most colossal task of rehabilitation of flood damaged equipment ever undertaken. The value of the electrical equipment involved alone was many millions of dollars. Consequently, a comprehensive knowledge on the part of those responsible for restoration of this apparatus to normal service was paramount. Hit and miss methods of cleaning and drying proved very expensive in many instances, whereas, approved methods carried on under the direction of skillful engineers were successful to a degree almost beyond expectation. It is, therefore, the purpose of this paper to cover for the benefit of those who may at some future time be called upon to perform similar work the salient points involved in reconditioning flood damaged electrical equipment. It is, of course, impossible to prescribe a set of rules which will cover every piece of apparatus and every condition, as these will vary from favorable to the most adverse. Much ingenuity and resourcefullness may be required in many cases to devise ways and means to use to the fullest advantage meager facilities available.

CLEANING

A power house or industrial plant, after a flood, is a sorry sight—oil, grease and mud covering everything, drift wood, debris and sand everywhere. The first step in the rehabilitation program is a thorough *cleaning* of everything; and this should be started at once to forestall further damage, along with a plan to provide heat to the building, while a general plan of drying is laid out.

Disassemble the apparatus as far as practicable and thoroughly clean all parts with clean water under moderate pressure (approximately 25 lbs.) to wash out all sand and silt. Too much pressure may cause damage to insulations that may be brittle from age and heat. Rinse with hot water, if possible.

Some solvent may be required to remove chemicals, oils, grease, etc. Several of the oil companies now put out cleaning solvents which are approved for removing grease from insulation. In general, there are three solvents which are readily obtainable, namely, petroleum distillates such as benzine and gasoline; carbon

FLOOD DAMAGED INDUSTRIAL ELECTRICAL APPARATUS

Presented before the A. I. & S. E.
Pittsburgh District Section
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tetrachloride; and a mixture of the two. Of these, carbon tetrachloride is the most active. A mixture of carbon tetrachloride and gasoline or benzine is second, and benzine or gasoline last. Any one of them is, however, sufficient in most cases, so that the choice depends upon the degree of fire risk involved and also upon the ventilation available to protect the operator.

Benzine and gasoline are highly inflammable, and their vapors form explosive mixtures with air. They are, therefore, permissible only where damage from fire would not be excessive and where there is sufficient ventilation to remove the fumes rapidly enough to prevent ever reaching explosive concentrations with air. When a solvent is applied with a spray gun, the frame of the apparatus being cleaned as well as the nozzle of the spray gun should be grounded with wire to carry away any static charge which may arise. Fatal accidents have resulted because of the failure to observe these precautions.

Carbon tetrachloride is a non-inflammable compound, but is to some extent toxic. The chief danger in its use lies with the fact that the vapor is heavier than air and will accumulate in pits, confined spaces, etc., and cause suffocation to anyone who may come in contact with it. Caution: The vapors of carbon tetrachloride may be especially toxic, even fatal, to persons who are under the influence of alcohol. It should never be used without complete ventilation, preferably a forced draft of air to carry the fumes away. An exhaust fan with its suction under the apparatus being cleaned and with its discharge outside the building is the best and surest protection to the men. Also, men should always work in pairs when using cleaning solvents, so that if one is overcome the other may assist him to fresh air.

A mixture of 50-50 carbon tetrachloride and benzine, or 60-40 carbon tetrachloride and gasoline, is non-inflammable, but the vapors mixed with right proportions of air are explosive. This hazard is greatly reduced, however, as compared with the use of benzine or gasoline when used alone.

There are two commercial types of cleaning fluids sold by the major oil companies. One is meant to conform to the specifications covering a solvent which is used in the dry cleaning industry and is safer than gasoline. It does not catch fire so easily as benzine or gasoline, but it cannot be considered non-inflammable. This material costs about the same as gasoline. The other type of cleaning fluid is a mixture of this solvent and carbon tetrachloride. It is similar to the carbon tetrachloride and benzine mixture referred to previously, and should be used with the same precautions. The cost of this material is intermediate between that of gasoline and carbon tetrachloride.

The cleaning should be done by sponging the parts with rags wetted by the solvent. Obstinate particles may be scraped off with a wooden scraper or scrubbed off with a fiber brush. After the apparatus is cleaned, it should be dried thoroughly by wiping and blowing out to remove all traces of the solvent, as its presence may soften the varnish and be harmful.

The steam "Jenny" is a device for heating flowing water and ejecting it under pressure, in the form of a spray. It also has an attachment for injecting a liquid solvent or a soap solution into the flowing water, and is a rapid, as well as an effective method of removing dirt, grease, oil, etc., from both mechanical and electrical parts.

As soon as possible, open up all bearings, clean them thoroughly, get all parts dry and coat all bearing and journal surfaces with moisture-free oil to prevent rusting. All oil piping, tanks, pumps, etc., should be thoroughly cleaned. In many cases, large amounts of sand have been found in them, and it has been necessary to dismantle all the piping and blow it out with compressed air or steam.

Serious damage to guide and thrust bearings has resulted from putting off this cleaning operation for a few days. Ball and roller bearings should be dismantled and thoroughly cleaned and lubricated. They may be full of silt, which will enter through the smallest openings.

DRYING

The second step in the rehabilitation program is the *drying* of the equipment, and here the best method in any specific case will be determined entirely by local conditions and the facilities and equipment available. In general, heat and dry air are necessary to remove moisture. Heat may be provided by either of two methods, or by a combination of both. The first is by external application of heat. The second is by circulating low voltage current through the windings and heating the conductors themselves. The third is a combination of the two.

Whatever the method of heating, a close check should be kept by means of thermometers, placed for easy reading, at the hottest spots so that the normal operating temperature of the apparatus will not be greatly exceeded. Heat application should be steady. Interruption of a heating operation to the extent that the apparatus approaches ambient temperature, allows moisture to condense on the conductors and undoes part of the work. Drying cannot be hurried; hours, or even days, are required to secure satisfactory results. Ample ventilation for the escape of moisture is essential to and hastens the drying operation.

A temporary "hot air" oven may be made of: Panels of heat insulating material secured to wood frames, or, sheet iron, brick, or concrete blocks lined with any of

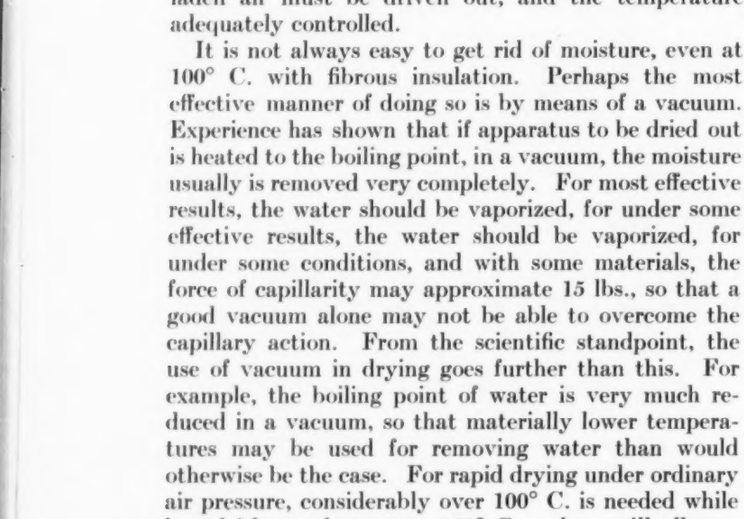
the many insulating materials, for the small equipment which can be easily moved; or such an oven can be built around large apparatus, which cannot be moved. Electric heaters, steam coils, radiators, stoves, or hot air furnaces may be used for heat. First, be careful to avoid fire risks; and second, provide for a positive air circulation. Salamanders or open flame heaters should be avoided. The dust, soot and fumes from them may make matters worse. Plenty of clean, dry air should be provided, and it must be allowed to escape as it becomes moisture-laden. Continued heating in an oven filled with moisture-saturated air may make conditions worse instead of better.

Electric range ovens, baking ovens, etc., can be used for drying small equipment such as meters, relays and other small parts. In all cases, however, the moisture laden air must be driven out, and the temperature adequately controlled.

It is not always easy to get rid of moisture, even at 100° C. with fibrous insulation. Perhaps the most effective manner of doing so is by means of a vacuum. Experience has shown that if apparatus to be dried out is heated to the boiling point, in a vacuum, the moisture usually is removed very completely. For most effective results, the water should be vaporized, for under some effective results, the water should be vaporized, for under some conditions, and with some materials, the force of capillarity may approximate 15 lbs., so that a good vacuum alone may not be able to overcome the capillary action. From the scientific standpoint, the use of vacuum in drying goes further than this. For example, the boiling point of water is very much reduced in a vacuum, so that materially lower temperatures may be used for removing water than would otherwise be the case. For rapid drying under ordinary air pressure, considerably over 100° C. is needed while in a fairly good vacuum, 100° C. or less, will allow a very rapid evaporation of moisture and a correspondingly rapid and thorough drying. Apparatus to be vacuum dried should be pre-heated.

A vacuum oven can be improvised from a boiler iron tank, adequately braced to withstand the external pressure. Electric heat or steam coils may be used for heating. Spark plugs may be installed in the cover in such a manner that apparatus inside, connected to them can be checked from time to time for insulation resistance. A suitable means for measuring the temperature of the apparatus within the tank is by resistance or thermo-couple. Ordinarily, twelve hours drying time in a good vacuum oven is sufficient for most apparatus.

An interesting view of Carnegie-Illinois Steel Corporation's Edgar Thompson Works, at Braddock, Pa., under 6 feet of flood water at Furnace "F", March 18, 1936. Note the steam rising from the cinder pit at right.



DETERMINATION OF INSULATION RESISTANCE

The degree to which the insulation properties are restored after drying is best determined by two tests: Insulation resistance, and high potential. Insulation resistance readings give a good indication of the general condition of the insulation, and readings, which are usually taken by a voltmeter or megger, should be taken as soon as the drying starts and should be checked at regular intervals thereafter as long as the drying process continues. Keep a careful record of each machine, for the change of the resistance to ground gives an indication of the drying results. The best way to obtain dependable records is to plot insulation resistance as ordinates and time as abscissas. If the readings are taken at equal intervals of time and a curve is plotted, a record of resistance is available for the entire period. Usually the resistance will drop as the machine warms up, reach a minimum, and then start to rise—rapidly at first. It may drop back slightly at times and then continue to rise at a slower rate as the moisture is driven out, indicating that drying has proceeded about long enough. An erratic curve may indicate leakage paths to ground, or weak insulation. Duplicate machines will often show no similarity in regard to insulation resistance.

METHODS OF TESTING INSULATION

The first and safer of the two common methods of measuring insulation resistance is by means of a high resistance voltmeter of known internal resistance. For this purpose, connect two "B" batteries in series with a 150 volt voltmeter, which will give a testing circuit free from any grounds and lack power to do any damage if there is a ground. Procedure: Connect the two batteries in series, connect one side of the batteries to the frame of the machine to be tested, making sure you have a good contact to bare metal. Connect the other side of the batteries to the voltmeter. Touch the free lead of the voltmeter to the point where the battery is connected to the frame. Call this reading "E". Next, connect the free load to the machine terminal and call this reading "V". From these readings, the insulation resistance is figured from the formula: $R = r\left(\frac{E - V}{V}\right)$ where "R" equals the insulation resistance of the winding in ohms, "r" equals ohms resistance of the voltmeter.

Any convenient commercial D.C. circuit may be used for testing insulation, but before doing so, a voltmeter test must be made to determine if the circuit is grounded. One side of the circuit must be free from ground, and the ungrounded side used in series with the voltmeter while testing. Also, use a low capacity fuse in series with the grounded lead connected to the frame of the machine. Failure to test and use a fuse in series may cause a short circuit and result in personal injury.

The second common method of testing insulation is that of applying a given voltage and find whether the insulation has sufficient dielectric strength to stand it. This has the one very objectionable disadvantage that if the insulation does not stand the applied voltage, the insulation will be punctured and the apparatus grounded and require repairing or rewinding. You do not want to puncture to ground where no fault exists; therefore, this method is not recommended for equipment that is known to be wet or in weakened condition. This test should not be applied until the equipment has been dried. It is difficult to establish a definite test voltage on account of the many variable factors which should be given consideration such as age of machine, class of insulation, its voltage class, general condition, etc.; however, a suggested value would be approximately 1½ times normal operating voltage.

Another method that is very convenient for measuring insulation resistance and that can be used for any winding whether AC or DC, is the use of a "Megger". One lead from the megger is connected to the winding and the other lead to the iron frame or core of the apparatus under test. One precaution that should be observed is to choose a megger whose voltage is not too high. The 500 volt megger is the most commonly used and is best for most applications, but this voltage has been found to be far too high for water soaked apparatus. In this case, a 100 volt megger should be used, or preferably, the voltmeter method described above.

OTHER FACTORS AFFECTING INSULATION RESISTANCE

Temperature has a marked effect on the insulation resistance. It is second only to moisture as a cause of variation in insulation resistance. Other things being the same, the insulation resistance becomes smaller as the temperature increases. It is apparent, therefore, that when insulation resistance values are recorded or discussed, that the approximate temperature of the winding should always be given.

As a machine increases in physical size, the insulation resistance will be less on account of the greater area of conducting surface. Likewise, an individual armature coil or small piece of insulation has an insulation resistance that is many times that of a complete winding. Also, as the thickness of insulation increases, as in high voltage machines, the insulation resistance increases accordingly. If a winding is connected to parts such as commutators, collectors, connections or ventilated coils where there is exposed copper, the resistance will be much less than otherwise as the resistance in these cases is usually controlled by the surface creepage from the exposed copper to the nearest iron; and if both moisture and conducting dust are present, the moisture bridges across from particle to particle and causes the resistance to be so low as to be dangerous to the insulation.

INSULATION RESISTANCE VALUES AS A GUIDE

As insulation resistance is so variable, in order to use it as a guide to the condition of the insulation of electrical apparatus, it is necessary to eliminate as many variables as possible. This can be done by the operators of the equipment obtaining data by test on particular machines at convenient times to check against, at later periods, when there may be very special reasons for wanting to know the general condition of the insulation. If data is available from previous readings on the particular motor or generator to compare with, the variables such as size, kind and quantity of insulation are eliminated, and even the great variable, temperature, is eliminated if the records include measurements through a range of temperatures. The record cards should include the full rating of the machine, the value of the insulation resistance and the approximate temperature of the winding at the time of measurement. It is preferable to rely on hot insulation resistance values rather than cold values.

The AIEE standardization rules state that the insulation resistance of a clean *dry* machine at its operating temperature of approximately 75° C. should usually be not less than that given by the following formula:

$$\text{Insulation Resistance in Megohms} = \frac{\text{Rated Voltage.}}{\frac{\text{KVA}}{100} + 1000}$$

Some insurance companies require an insulation re-

Furnace "H" at the Edgar Thompson Works where 10′ of flood water over the roadway completely inundated the vehicle tunnel.

sistance of one megohm per 1000 volts of operating voltage with a minimum of one megohm. On field windings the minimum should be of the order of ½ to 1 megohm, depending on the size of the machine. It should be especially noted that this is for clean *dry* machines at their operating temperatures. A definite rule cannot be set for machines whose insulation is not dry or nearly so. Motors operating in damp locations will have much lower values than those determined by the above formula, and machines may fail which have much higher values than these. It is very evident that insulation resistance measurements will generally record the presence of moisture in insulation and give an idea of its magnitude, and also record the presence of excessive conducting substances on the windings. However, insulation resistance does not determine the dielectric strength of insulation, although the dielectric strength increases with increase in resistance and decreases with decrease in resistance.

SUGGESTIONS FOR DRYING VARIOUS TYPES OF EQUIPMENT—SPECIFIC EXAMPLES

The insulation ordinarily applied to industrial electrical apparatus is known as Class "A", defined by the AIEE standard as "Class A insulation consists of cotton, silk, paper and similar organic materials when impregnated or immersed in oil". Because of the nature of Class A insulation, the highest temperature obtained during any drying operation should not greatly exceed the operating temperature of the apparatus.

SQUIRREL CAGE AND WOUND ROTOR INDUCTION MOTORS
120 Volts, 240 Volts and 480 Volts Classes

Drying in an oven 20 to 24 hours is generally sufficient for the windings of such apparatus. Collectors may require special drying, or in some cases, re-insulation. Separate the apparatus in the oven so that air can be circulated around it. When an insulation resistance of one megohm per 1000 Volts is attained, apply a coat of good air drying varnish.

In extreme emergency, it may be expedient to place low voltage squirrel cage induction motors in service as soon as surface moisture has been removed, but in every case, bearings should be thoroughly cleaned. Preliminary operation for a few hours without load is desirable. Many such motors with mechanically sound insulation will dry out in service, but the "life" of the insulation may be shortened and some may fail.

DIRECT CURRENT ARMATURES, FIELD COILS AND COMMUTATORS

DC armatures and field windings may be dried as described for AC windings. Commutators are especially difficult to dry, particularly if they have been warm and expanded when submerged. It is advisable to remove some of the clamp bolts or even to loosen the front V ring and tip the armature to drain out trapped water. When vacuum equipment is available, apply a pre-heat temperature of 115° C. for two hours; then apply a 27 to 28 inch vacuum for 7 to 10 hours at 115° C. If commutators are dried at atmospheric pressure, several days may be required to obtain an insulation resistance of 1 mogohm, and even then, the insulation may not be thoroughly dried.

A heated enclosure or oven for large DC motors is recommended, with hot air blown under the commutator bars. Drying time will be greatly reduced if the machine can be rotated slowly with short circuited armature and weak shunt field excitation. The series field should be left out of circuit, or reversed to buck the shunt field, and the generator short circuited through an ammeter and circuit breaker or fuse. Sufficient load current can then be circulated through the short circuit until desired temperatures are obtained. *Caution:* Extreme care should be used in first putting on the short circuit, for unless the series field windings are bucking the shunt field, the generator will pick up on residual magnetism, act as a series generator, and will sometimes produce surprising as well as serious results. Unless the circuit breaker can be set very low, it is advisable to connect a fuse in circuit for the first try. This should be done with the shunt field circuit open.

Shifting the brushes forward from the running position will cause sparking which will increase the commutator heating. This should not be carried far enough to spoil the commutator surface so as to make grinding or turning necessary. There are no short cuts to commutator drying, and a large machine may take from ten days to two weeks to dry.

Shunt field coils may be dried by passing current through them; however, this is not recommended inasmuch as in some cases where current was applied to water soaked coils, the current leaked between turns and electrolysis apparently deposited copper salts in the cotton covering. If too much current is circulated through the coils, the turn insulation may be ruined by overheating. An idea of the condition of the insulation within the coil may be obtained by voltage drop measurements taken across each coil. Vacuum drying where possible, is highly preferable.

ALTERNATING CURRENT GENERATORS, SYNCHRONOUS MOTORS AND HIGH VOLTAGE INDUCTION MOTORS

After the bearings, oil piping, windings, etc., have been thoroughly cleaned on large turbo generators, which have been wetted by flood waters, the field should, if possible, first be revolved at not greater than one quarter speed until there are no signs of moisture being thrown out. External heat should then be applied and continued until the insulation resistance is at least 50,000 ohms before voltage is applied to it. When drying has proceeded to a point where it is considered safe, the generator may be put on a short-circuit heat run. The current should be brought up very slowly and temperatures carefully watched, both in the windings and the core. Some turbine generators have a large "throw" or span of the end windings and large ampereage per slot may develop high temperatures in some of the teeth of the core. Temperature indicating coils that are located to show the temperature of the coils under load, will not show these hot

spots. Since this heating is a function of the speed, short-circuit drying should be done on these machines at one third to one half speed. *Caution:* First obtain from the manufacturer the speed at which to conduct such a short circuit heat run. If additional heat is required, the surrounding air may be raised by restricting air circulation by baffles or by heating the ingoing air with electric heaters, stoves, steam radiators, etc.

In other machines having temperature coils in the slots, the temperatures measured by these coils may be held at from 85 to 90° C. Temperatures taken by thermometer on the outside of the winding should be held at about 75° C. This is due to the fact that there is considerable difference in temperatures between the inside and the outside of the coil. If temperatures are brought up too rapidly and carried too high, gases and vapor may be generated in the inside of the insulation and may develop such pressure that they are forced through the insulating layers in such a way as to break the continuity of the layers. In view of this, it has been found that the best method of drying out is to enclose the machine and to change the air circulation so that the hot air, coming from the outlet, passes again to the intake and is continually re-circulated around the machine. Care should be taken that the leakage of air shall be greater than is necessary for carrying off the water vapor. By this means, the air friction and windage will assist in gradually heating the machine so that only a small current in the short circuited armature will be required to bring the machine up to the desired temperature. Needless to say, constant vigilance by an experienced operator is necessary to obtain satisfactory results.

After the resistance to ground has reached a fairly constant value, approximately 1 megohm per 1000 V. of operating voltage, the machine should be brought up to voltage by easy steps, with open circuit at the terminals, running some time at, say, ¼, ½, ¾, and full voltage, inspecting the machine carefully at each step.

The new flood wall surrounding the Steubenville plant of the Weirton Steel Company is designed to protect the plant to a stage of 55′ which is 2 feet higher than ever recorded.

SYNCHRONOUS MOTORS

Large synchronous motors are best dried in a temporary housing built around them, heated to 90° C., and with some means of circulating the air to all parts and changing it as it becomes moisture-laden. Heat for this purpose should preferably be derived from electric heaters or steam radiators. It may save time in some cases to remove the pole pieces and dry the field coils in an oven, especially if the insulating collars need replacing. The rotor should be turned over from time to time to drain out trapped water.

INDUCTION MOTORS

Slip ring motors can be dried by short circuiting and blocking the rotor and applying about 20-25% voltage to the stator windings. The voltage should be controlled so as to get a temperature of around 90° C. in the stator and rotor windings. The rotor should be moved occasionally to permit water pockets to drain. The same precautions should be observed as described for AC generators.

Dry until an insulation resistance of 1 megohm for each 1000 volts operating voltage with a minimum of 1 megohm, is obtained.

TRANSFORMERS
Power

Considerable engineering knowledge as well as experience is required to properly dry and recondition transformers after they have been submerged in flood waters, consequently, only a few general suggestions can be given here.

PRELIMINARY INSPECTION

To determine the condition of a transformer, the first thing to do is to check the oil. Oil of normal dryness will test 22 K.V. or higher, in the test cup. If it is much lower than this value, it indicates the presence of moisture and should be dried in a suitable filter press or centrifuge.

If the customary oil test set is not available, a quick, simple and fairly reliable check to determine whether excessive moisture is present in oil is by means of the "hot wire" test. To apply this test heat the end of a wire or nail to a dull red temperature and immerse it slowly in the oil. If moisture is present, there will be a hissing or sputtering noise; and if no moisture is present the oil will smoke or burn without noise.

Try to determine from observation whether or not the transformer is very wet as this will serve as the first guide in determining the amount of drying required. Water in the bottom of the tank does not necessarily mean that the core and coil assembly is very wet.

If water has leaked into the transformer case, and replaced the oil, the core and coil unit may be covered with mud and debris. In such a case, the unit should be carefully removed from the tank and the windings washed clean.

DRYNESS REQUIRED

High voltage transformers require much more careful drying than low voltage. Distribution transformers of the low voltage class may even dry themselves out with continued operation. No definite rules can be laid down for the amount of drying required. The megohm resistance of the insulation to ground should be from ¼ to 1 megohm per 1000 v of operating voltage when satisfactorily dried. Ordinarily, the upper figure should be used, but in an emergency where time is vital, the lower figure may be considered satisfactory, particularly for the smaller and lower voltage distribution transformers. The insulation resistance should always be measured hot, 60 to 70° C., without oil in the tank. When measured cold, a very high reading can be obtained, even though the transformer may be quite wet. Fill the tank to the proper level with new, dry oil.

Using the above formula, a 2400 volt winding, should have an insulation resistance of from ½ to 2½ megohms. On the other hand, a 66000 volt winding should probably have at least 33 megohms. The megohm resistance is a function not only of the dryness, but of the size of the transformer and of the arrangement of winding as well. A reasonable value of resistance for a given type of transformer can be determined by measuring a duplicate unit known to be dry, or by noting the highest value obtainable after extended drying on one or two sample units.

DRYING TIME

Drying time will depend, to a large extent, on how wet the transformer is—also the size and amount of insulation involved. A large unit requires more time than a small unit, and a high voltage unit requires still more time because of the greater amount of insulation. Drying time will also depend on the method of drying used, temperature of oven, etc.

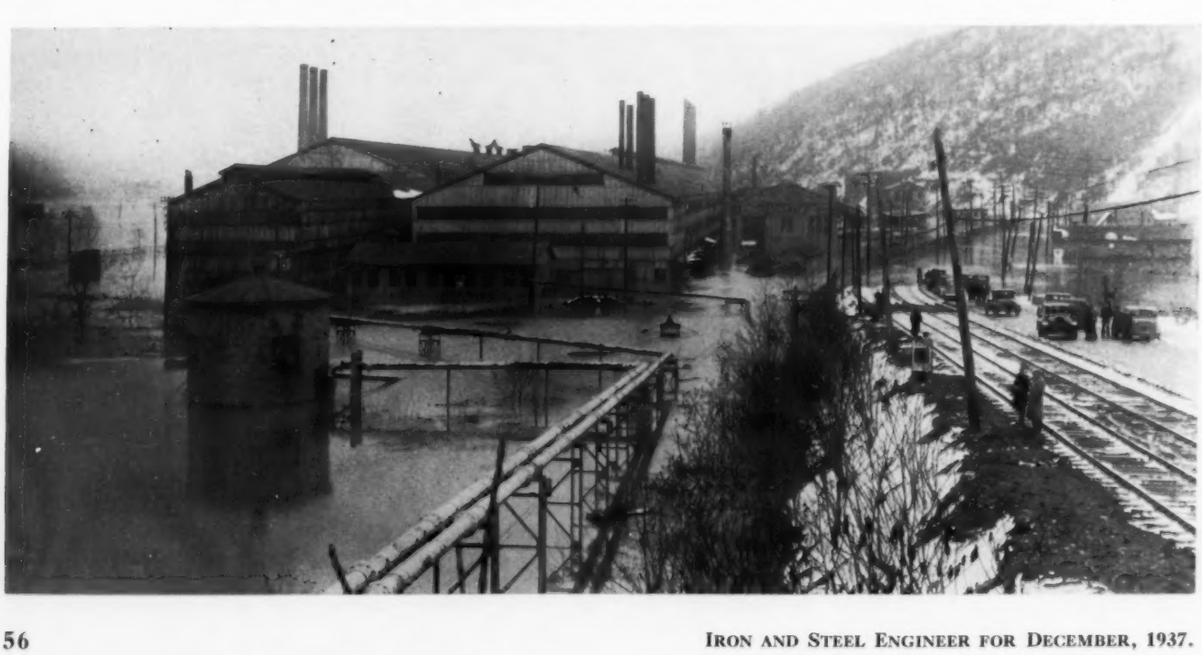
It has been found from practical experience that most of the smaller distribution transformers can be dried in a well ventilated oven in from 12 to 24 hours, while dry type instrument transformers that have been thoroughly soaked, require several days to dry by the same method. This time can be greatly reduced when drying is done in a good vacuum oven. A very large high voltage transformer, dried in the field, may require as long as two to four weeks to thoroughly dry.

METHOD OF DRYING

The best practical method of drying transformers wet in the flood is by external circulation of hot air. The best method of heating the air is by electric space heaters or grids if sufficient power is available. Steam coils or radiators may be used. Any stove or furnace could be used if care is taken to prevent products of combustion entering the transformer and to protect against fire. *Caution:* Never locate heaters where oil will drip on them. The temperature of the air circulating around the windings may be from 70° to 110° C., the hotter the air, the faster the drying.

Almost any kind of fans or blowers may be used to circulate the hot air. It is not necessary to blow the air violently through the transformer windings. Only a moderate circulation is required. The hot air should enter at the bottom and escape through openings at the top. If large transformers are to be dried, their own tanks may be used as ovens. The hot air can be blown in through the main drain valve and allowed to escape at the man hole in the cover. If this is done, put baffles inside the tank and direct the air through the oil ducts. In drying large transformers, it is also helpful if some current can be circulated in the winding to supplement the circulating air. To do this, short circuit the low voltage winding and apply about ½ to 1½% of normal

Toronto, Ohio Works, Follansbee Brothers Steel Company, showing flood waters at their crest.



voltage (depending on impedance of windings) to the high voltage winding. Adjust the current to give a winding temperature of about 80 to 90° C., measured by resistance method. Using formula $T = \frac{R}{r}(234.5+t) - 234.5$ where T = calculated temperature; R = hot resistance; r = cold resistance at temperature t.

INSULATING OIL

The insulating oil is just as much a part of the transformer in which it is used as any of the other materials which are built into it. The oil not only provides an electrical insulating medium, but also has to carry the heat away from the windings. As all oil is subject to deterioration, even under the most favorable conditions, it is recommended that only new oil be returned to high voltage transformers after drying. Reconditioned oil may be used in low voltage distribution transformers and low voltage circuit breakers.

DIELECTRIC TESTS

If possible, give all dried transformers some sort of dielectric test before replacing them in service. Potential tests can usually be made. In general, do not apply more than 75% of the regular testing voltage, which, in the higher voltage classes is double the line voltage, plus 1000. For distribution transformers, test voltages are much higher, but for emergency purposes, it should suffice to test them to ground and between windings with two to three times normal voltage on the high and 4000 volts to ground on the low.

Transformers, such as auto, motor starting and instrument types should be dried in an oven. Tests should be similar to those applied to power transformers.

OIL CIRCUIT BREAKERS

Drop the tanks, throw out the oil and dry the tanks thoroughly with clean absorbent cloth. Insulating materials, such as tank liners, barriers, lift rods, etc., should be either dried in an oven or replaced. Absorption of moisture and drying usually distorts these parts to such an extent that replacement is eventually necessary. Bushing current transformers, closing coils and trip coils should be removed and baked. Control wiring should be either dried or replaced. Operating mechanisms should be cleaned and oiled to prevent rusting.

AUXILIARY APPARATUS

As a rule, instruments, meters, relays, voltage regulators, electronic devices, etc., that have been damaged by flood conditions should be returned to the manufacturer for overhauling, adjustments and tests, or replacement altogether. In no case should this work be attempted by anyone except a competent instrument man.

The chief enemies of insulation are dirt, moisture and temperature. Electrical apparatus which has been submerged by flood waters may be poluted with dirt, oil, grease, acid and other harmful foreign material. There are no short cuts in reconditioning flood damaged electrical equipment; and unless proven methods of cleaning, drying and testing are used, the damage already done may be greatly aggravated.

Although this paper does not, and could not, cover all specific problems that may arise during an emergency, it does give a general procedure, which, if followed, will produce satisfactory results.

DISCUSSION

PRESENTED BY

G. R. CARROLL, Electrical Superintendent, Jones & Laughlin Steel Corp., Aliquippa, Pa.
T. J. FLAHERTY, Electrical Superintendent, American Rolling Mill Co., Ashland, Kentucky.
J. C. DAVIDSON, Standard Underground Cable Company, Division, General Cable Corporation, Pittsburgh, Pennsylvania.
J. J. BOOTH, Asst. Chief Main. Engr., Carnegie-Illinois Steel Corporation, Duquesne, Pa.
JOHN KASPARI, Assistant Electrical Engineer, Weirton Steel Company, Weirton, West Virginia.
J. J. DURKIN, Service Department, General Electric Co., Pittsburgh, Pa.
T. E. HUGHES, Chief Maintenance Engineer, Carnegie-Illinois Steel Corp., Duquesne, Pa.
J. S. MURRAY, Chief Electrical Engineer, Follansbee Brothers Co., Follansbee, West Va.
L. F. COFFIN, Supt. Mech. Dept., Bethlehem Steel Company, Sparrows Point, Md.
N. C. GOIN, Sales Department, Westinghouse Electric & Manufacturing Company, Pittsburgh, Pennsylvania.
JAMES FARRINGTON, Electrical Superintendent, Wheeling Steel Corp., Steubenville, Ohio.
WRAY DUDLEY, Electrical Superintendent, National Tube Company, McKeesport, Pa.

J. S. MURRAY: As usual, we will call on the more active members to discuss these papers, as I understand some of them have prepared written discussions, after which the meeting will be thrown open for general discussion. I believe we will all agree that the papers we have heard tonight illustrate the real seriousness of the situation as it existed during the flood in March, 1936 in the Pittsburgh District, and it is particularly serious when one considers the possibility of a recurrence of these flood stages, or possibly much higher flood stages. It is evident also that considerable work has been done to protect electrical equipment in this area, both in the central stations and in the steel mills, and no doubt future flood damage will be minimized to a very great extent.

Later on, after a large part of the discussion was presented, I believe I pointed out the need for caution and investigation of the possibility of the dangerous

shifting of buildings, such as power plants and substations, if such buildings are constructed or modified so that they are made water-tight. I mentioned the shifting of the large power plant at the Ohio River Edison Company at Toronto, Ohio, under these conditions from pressure, where it was necessary to actually let the flood waters into the 11,000-volt switch gear department of the station. I believe Mr. Farrington will elaborate on this at some length in a counter-discussion.

WRAY DUDLEY: The papers presented by Messrs. Hester and Cranson, and Messrs. White and Airhart, convey a very clear and vivid picture of the devastating effect of flood waters upon electrical equipment, and also give a striking description of the tremendous amount of work, expense, and length of time involved in restoring public utility electric service in this district. The information presented contains data of practical value to engineers who are responsible for equipment located within the danger zones, and our thanks should be extended to the authors. I feel that the Association of Iron and Steel Engineers is rendering a service of distinct value to its members, and others who may be concerned, in sponsoring this meeting and publishing the information here presented.

Within the active life of our present membership history may repeat itself and nature may impose another St. Patrick's Day flood upon us. If that should occur, and human nature being what it is, it is probable that many of the steel plants in this area will be as equally devoid of flood protection as they were in 1936. The damage to our electrical equipment will be equally serious, and probably of greater magnitude because of more extensive electrification. If those who read the articles presented here tonight are still responsible for rehabilitation services at that uncertain future date, they should recall the practical information recorded in these articles and be able to refer to them for the instruction and guidance of those actively engaged in directing and expediting the safe return to service of the equipment for which they are responsible. There was a woeful lack of published information concerning rehabilitation methods and processes in the Spring of 1936. Practically every plant had to start from scratch and develop its own individual program. In doing this, much valuable time was lost.

There is not much which I could add to the various suggestions presented in the papers for cleaning, drying and testing the submerged equipment. The flood conditions encountered in a steel plant do not greatly differ from those described by the authors, and the methods of rehabilitation are essentially the same. We do have an over abundant supply of oil and grease, and in limited areas there may be acidulated water present due to submerged pickling tanks. Water for washing away the mud and sand, a safe solvent for cleaning off oily deposits, a plentiful supply of hot, dry air, drying ovens, resistance measuring devices, time, labor, and money, will all be required in generous volume before normal operation can be resumed. And then over a six to twelve month period. or even longer, occasional failures may be expected in cables, bushings, field coils, and miscellaneous parts, which can be attributed to entrapped moisture or to weakened insulation which was not detected during the drying operations.

While it may be impractical in many cases to apply flood prevention devices to much of the existing steel mill equipment, there are certain preventive measures which can be taken to lessen the destructive effects of future floods while we are waiting for governmental flood prevention measures to become effective, and amongst these, those which will be described may be of some interest.

We found that stranded, insulated cables lying in a horizontal position afford a very good place for water to be trapped, provided either end is submerged and the cable is not water-tight, as practically all were not. It is almost impossible to remove this water except by drainage with the cable in a vertical position and circulating heated air through and around it, which of course is usually impractical. The grade of rubber usually used for insulation purposes on low voltage cable is a more or less hygroscopic material, and when subjected to internal heat and moisture will frequently develop failures at weakened sections. This experience suggests consideration of the newly developed, moisture resisting, deproteinized rubber, for insulation of low voltage cables in the flood areas, and their installation on a slight incline and without U bends in order to facilitate drainage and drying operations.

Numerous accessory structures such as pot heads, certain types of circuit breakers, enclosed bus structures, etc., which require insulating by pouring in heated, plastic, compound, possess the unfortunate facility of developing voids either while being filled or because of expansion and contraction under operating conditions. If submerged under flood conditions the voids will frequently become filled with water, which it is very difficult to detect by resistance measurements. Under the influence of voltage stress at operating temperatures the entrapped moisture will sometimes cause a gradual failure of insulation strength, until finally a destructive ground or short circuit develops. A suggested remedy is to avoid the use of compound filled accessories wherever possible, and if necessary to use them in connection with cable, to select a pot head which can be made up with a joint that will remain water-tight under the greatest hydraulic head which will be encountered.

It will sometimes be found that both large and small D.C. motors or generators are fitted with commutators so constructed that it is impossible to obtain access to the annular space concentric with the wearing surface of the commutator bars. Moisture will invariably find its way to the mica surfaces in this space, and it will be found that drying out this type of commutator with a blast of heated air is a very difficult task. It is not practical to circulate hot air freely through the small spaces which can be made available by loosening V ring clamping bolts, and the extraction of the vaporized moisture at drying temperatures around 100° C. is quite a problem. In the case of a large 600 volt commutator of this type having dimensions of 70″ x 16½″, it was finally found necessary, after ordinary heating methods had failed, to raise its temperature to 150° C.

and hold it there for 48 hours, before a reasonably high megger reading could be secured. The heating was accomplished by winding about 46 ft. of ½" x .025" nichrome ribbon around the commutator and applying sufficient current at 250 volts D.C. to raise its temperature to a point equivalent to a dull cherry red. The copper bars were protected against direct contact with the heated nichrome ribbon by first wrapping the commutator with asbestos paper, a layer of which was also placed over the ribbon for heat conservation purposes. During this heating operation, commutator clamping bolts had been loosened at 60° intervals and a blast of air at approximately 135° C. was forced through the restricted openings. As a result of this heat treatment some unevenness of the commutator surface developed, and after some weeks of operation it was finally necessary to turn and polish the surface before smooth brush operation was secured. In the future when direct current equipment is to be purchased for installation in zones subject to floods, it would be well to examine the commutator construction to make sure that its design would lend itself to drying operations.

The destructive electrolytic effect on various contact surfaces in relays, meters, etc., from acidulated water originating from submerged pickling tanks in the presence of leakage current flowing from substation storage batteries, indicates the desirability of locating them above flood stage where switches can be opened instead of hiding them in the basement. Waterproofing of basement and walls of important substations is a wholesale method of preventing flood damage to large masses of electrical equipment, which will frequently be found relatively inexpensive and effective. This plan could well be given first consideration in the design of future substations. A source of emergency power for use during the rehabilitation work, and various types of pumps for dewatering operations are matters of prime consideration.

When using the megger on some of the D.C. armatures a peculiar erratic motion of the needle would be observed as long as hidden moisture was present, and likewise a substantial difference in readings would be obtained by reversing megger leads. The erratic motion would give the impression that a counter E.M.F. was being generated in the armature. This would occur even in armatures entirely removed from the frames, and without connection of any sort other than the leads to the megger. Other than the possibility of galvanic battery action or thermal electric currents, no reasonable explanation of these phenomena has yet been suggested, however, both puzzling indications would gradually disappear as the armature approached a dry condition.

Due to the substantial capacity effect residing in the insulated structure of large pieces of electrical equipment, it is necessary to apply megger current for as long as five minutes or more before constant readings will be reached. Hand operation of the megger for sustained periods tends to become somewhat wearisome to the operator and, if he slows down the R.P.M. too much, erroneous readings may result. A motor operated megger would eliminate this chance of error and would be helpful in conserving energy for more important duties.

No doubt every submerged steel plant could duplicate the few items I have mentioned, and add many others of equal or greater interest. Enough has been said, however, to indicate that flood rehabilitation and prevention are matters of considerable importance to the steel mill engineers wherever floods are liable to appear, and that the papers given here tonight should be of substantial value and interest to them.

JAMES FARRINGTON: The papers on flood protection and rehabilitation presented by Mr. Hester, Mr. Cranson, Mr. White and Mr. Airhart, have been most interesting and instructive and many of us would like to have had this valuable information at the time of the 1936 Flood.

There is not much more that can be added and we will only present a few suggestions under the following seven headings:—

1. WATER PROOFING BUILDINGS CONTAINING ELECTRICAL EQUIPMENT

Buildings subjected to flood may be water proofed at a small expense by painting them with a water proof paint, bricking the windows and doors with quick drying cement and bricks, or providing iron panels that can be easily and quickly applied.

There is a firm which will guarantee to water proof walls from the inside where it is impossible or costly to get at them from the outside.

Where possible, the floors of the buildings should be above flood level, thus removing all possibility of interruption of service. In most cases this extra cost is justified.

2. PROTECTING ELECTRICAL EQUIPMENT

Electrical equipment may be protected in three general ways:

1—By raising on blocking.

2—By covering the windings with a heavy grease with a stuffing box around the shafts; rubber gaskets where cover is bolted to base on floor, and marine door at bottom of foundation.

3—Where a steel house is placed over a motor a suction pipe can be put down through the top of the house to take out any water which might get in.

The water can be kept out of a blooming mill motor by welding a plate to the driving shaft and bolting this plate to an iron frame concreted in the wall surrounding the motor. We have used this method successfully five times.

Our motor room was water proof up to a river stage of 50 feet but as the river rose to a stage of 51.6 feet it was flooded. We are now raising all openings into the motor room to a river stage of 57 feet, as the Ohio Power Company which furnishes us power, can service us to a river level of 57 feet. We are also raising our substation to the same level.

We are making up estimates to put a steel house over all large motor drives, closing the opening in the foundation with marine doors, installing surface air coolers with blowers in the motor pit. This will pro-

vide clean air for operation and a water tight compartment against a flood.

We have resorted to all three methods with good results.

In pump houses or basements where the water came through the sides in many small streams, curtains of canvas can be placed along the walls about twelve inches away, thus deflecting the water to the bottom and removed with sump pumps.

Combination gasoline and electric pumps of 5000 G.P.M. can be purchased for $2500.00.

Thickness of floors of basements should be checked as to the maximum pressure they can withstand as the flood head may be sufficient to crack same.

All unanchored sections should be braced from the beams above. We expect to allow the water to rise to a level of 7 feet in the basement for a 57 foot stage in order to relieve the pressure.

3. CLEANING ELECTRICAL EQUIPMENT THAT HAS BEEN FLOODED

All large electrical equipment which has been completely submerged should be thoroughly washed with clean water and blown out with compressed air. If covered with oil or dirt, wash with safety clean and wipe with rags and cleaned with long brushes. Small motors, oil circuit breakers and oil emerged starters should be taken apart, washed, blown out with compressed air and wiped off.

Large armatures may be cleaned by revolving them slowly in a semi-circular pan filled with carbon tetrachloride or safety clean. In using carbon tetrachloride great care should be taken as it will remove the varnish if left on too long. In many cases the pan can be made with one side detachable and inserted between the armature and frame, thus eliminating the cost of dismantling the motor.

Buss bar installations should be washed, blown out with compressed air, and all expansion joints taken apart, cleaned and reconnected.

It is a question in our minds where a large motor or generator has been completely submerged if it is not better to dismantle the motor, dry and clean as described above, replacing or reinsulating the windings that are defective.

4. DRYING ELECTRICAL EQUIPMENT

1. *Large Motors:*

After the motors have been cleaned as noted above, every other bolt should be removed from the commutator, and space heaters attached around it, low voltage from a separate source, such as a welding machine, applied to the shunt fields or stator and a stream of hot air blown on the motor from an electric or steam heated blower. Drying by blowing hot air alone on the motor does not seem to produce very quick or good results.

It is very essential to keep the moist air moving when using a canopy over the motor.

Revolving the armature greatly helps the removal of moisture.

AC motors may be dried out by sliding the stator along the armature and applying low voltage three phase current as the amount of current can be varied at will.

Commutating fields and pole face windings seem to be the hardest to dry out and where possible should have full load current passed through them from a plating generator at 6 volts.

2. *Small Motors:*

After the fields and armature have been cleaned they should be placed in a drying oven made of canvas or sheet iron, or in an annealing oven and the temperature maintained around 90 deg. C. and ventilation provided.

The front mica cone should be removed from the commutator before placing the armature in oven.

3. *Control Apparatus:*

Contactor, relay coils, and wiring may be dried out by covering panels with a canopy and blowing hot air on them, connecting the coils in parallel on low voltage or by removing from the panel and drying out in an oven, the last method seemingly the most satisfactory.

Carbon brushes should be carefully examined for if they are of a porous type no amount of heating will make them serviceable again.

Large Motors:

The modern designed moisture proof shunt field coils were extremely hard to dry out and in some cases they were still damp after 8 days in an oven at a temperature of 110 deg. C. In many cases, if shunt coils are insulated from ground and current passed through them for 20 to 30 days they will rise to a resistance of 200 to 1000 megohms.

4. *Cables:*

Lead covered control cables with untreated jute fillers were almost impossible to dry out as the jute acted as a wick.

Where cables were only wet three or four feet from the end they could be dried out by the application of heat at the ends.

Where cables were wet for a distance of 25 feet or more it was practically impossible to dry them out.

Large single conductor lead covered cables of 500,000 CM or larger may be dried by cutting off a 2″ or 3″ band of the lead at the low end and keeping the end thus exposed dry.

It was not necessary to remove the insulation as in most cases the moisture was between the insulating band and the lead sheath.

5. *Pot Heads:*

In most cases pot heads should be removed, dried out, and replaced upon the cables after same has been dried.

6. *Transformers:*

Have nothing to offer in addition to that stated by the authors.

5. TESTING ELECTRICAL EQUIPMENT

Test with a megger as recommended by the authors, using an ohmeter until the resistance rises to be safe for a megger. Where shunt fields are separately excited they may be operated with as low a resistance as 25000 ohms to ground on a 250 volt circuit if the drop across their terminals is approximately the same.

When acid has been in the water a chemical action

is set up that will produce a reading as high as 150 milli volts between the commutator and ground, which will disappear as the machine begins to dry out.

The equipment should be tested first when it has been air-dried, second after 24 hours of heat application and every 12 hours thereafter until the resistance has raised to a safe operating condition.

The resistance should fall between the 1st and 2nd reading and steadily increase from then on. For safety there should be three successive increases with the last reading equal to the formula: $\frac{\text{Rated Voltage}}{\frac{\text{KVA} - 1000}{100}}$

After the equipment has been put in service it is well to megger same every 24 hours if possible as moisture is sometimes liberated reducing the resistance.

Cables should be tested quite often until their resistance remains stationary at a safe value of ten megs per 1000 volts service.

6. REINSULATING EQUIPMENT DAMAGED BY FLOOD

In many instances it is quite difficult to determine whether it is better to try to dry field coils without removing the insulation, or to remove the insulation, dry out, and insulate.

Where it is very urgent to get a DC machine in service as soon as possible, time can be saved by removing the insulating from the field coils, drying out and reinsulating same. This is especially true of small auxiliary motors.

When brush holders are insulated with a porous fibre or paper tape they may require a considerable time to properly dry out and time will be saved by replacing with new insulating material. This also applies to collector ring equipment terminal boards, bracing straps on risers of large armatures and series field connecting strap bracing.

Should commutating pole windings and pole face windings not rise to the proper value after long application of heat and windage they should be removed and reinsulated or replaced by new ones.

After the windings have been dried to a point where the resistance to ground is sufficiently high they should be sprayed with a good varnish and baked if possible.

Wedges should be carefully checked as they are apt to become loose when heated after being wet.

7. DESIGNING ELECTRICAL EQUIPMENT FOR FLOOD CONDITIONS

Large Motors:

The modern compact or closed type of shunt field coils were very much harder to dry out than the old ventilated or open type of coil.

The older ventilated type coil dried out in thirty-six to forty-eight hours, while most of the modern type required from 15 to 30 days to dry out.

The above condition would indicate that where field coils will be subjected to flood they should be wound with an air space between the coil and pole pieces to allow moisture to escape when drying out. A non-porous insulation used in winding the coil may help.

Commutating field coils and pole face windings should, if at all possible, be insulated with a non-porous insulation as they have given a great deal of trouble and in many cases the motor had to be dismantled and the coils replaced.

All places where fibre or fish paper is now used should be insulated with a non-porous material.

Wedges should be made of a non-rusting metal.

Vent holes to be placed in the commutator casting to allow moisture to escape thus making it unnecessary to remove the bolts.

Small Motors:

Field coils to be completely encased in a sealing compound with the leads insulated with synthane rubber that is impervious to water, oil, acid or heat and the complete coil vulcanized which will allow operating under water. This type of insulation is now available.

Control Panels:

Panels to be of steel with wires bare, rubber cleats and bushings.

Contactor and relay coils to be wound with enameled wire encased in a compound and compound bored out to fit steel sleeve.

Cables:

Each conductor rubber covered and rubber band over all conductors, no other filling and terminals soldered on ends and all rubber vulcanized.

The above remarks cover the conditions encountered and some of the means used to correct them and we hope they may be the incentive to suggest better and cheaper methods of combating Old Man River.

G. R. CARROLL: I am sure that we will all agree that the authors have covered this subject very thoroughly, in fact, I can not think of any items that have not been discussed and after it is all summed up, it is certainly evident that a very remarkable job has been done in rehabilitating equipment that has been under flood water. It is a very discouraging sight to see a motor room containing thousands of dollars worth of equipment just after it has come out of a flood. In fact, it seems almost impossible to imagine the equipment back in operation again without complete rewinding, but those of you who have had this job to do have made a remarkable showing. Mr. Farrington has stated, one of the most difficult things to combat during a rehabilitation period is the impatient attitude of the operating executives in getting things back into operation. Many of you will agree that it took a lot of persuasion to convince them that in this case, haste certainly makes waste. Too many instances are on record where the electrical people were prevailed upon to take unwarranted chances on putting electrical equipment into operation before it was properly dried out, in fact, I heard of one case where considerable boasting was done for two (2) or three (3) days after putting an M.G. set back into service only to find that in a short time they had to completely rewind the equipment due to breakdown of insulation.

I would like to emphasize the remarks made by Mr. Dudley in extending the appreciation of the Association to these authors for their efforts in getting this material together, as it certainly makes a valuable record to add

to the files of our Association and it would have been a great help had we had this data at hand during the flood of 1936. I am sure another such catastrophe will be made a whole lot easier because of our access to this valuable information.

T. J. FLAHERTY: I do not think I can add anything to the papers that have been read. They are very complete, and seem to cover about the same experiences we had. In our plant we had 73 ft.–8 in. of water, but covering a motor with water 20 feet deep is as bad as 73 feet. One of our neighbors had 80 feet. They attempted to lift a turbine with a crane and water went over the crane. The whole thing was very interesting to me. There is one item that we have been troubled with more than anything else since the flood, that is, cables, particularly high voltage. I understand the rest of you have been troubled the same way. I have an idea which I have mentioned to several practical men and technical men on a method of trying to combat the difficulty in future floods, whereby we can make a rubber boot and disconnect your wires above the pothead, take the pothead off, or cut a piece out of conduits below potheads, put your rubber boot over the cable, clamp your rubber boot to the cable where you cut conduit out and seal the water out of the cable entirely. I have talked to quite a few fellows to get some objections, and I haven't had anybody yet to explain the objections to it. If there are any possibilities in it or otherwise, I do not know, but the biggest part of our troubles have been with the cables since the flood. We have manufacturers now making rubber boots for test; we will throw it in a pond and try it out for leaks.

One item mentioned in the papers on open commutators for large equipment, we found as Mr. Farrington did in his paper that we got first-class results by winding space heaters around commutators (as close together as possible) taking every other bolt out of commutator and bringing the commutator up to about 125 degrees C. I believe that is the quickest method. Mr. Dudley also mentioned an idea that I believe will do the trick. I believe the safest thing is not to open a commutator up. I enjoyed all the papers and do not think I have anything more to add.

J. C. DAVIDSON: From the remarks of Mr. Farrington and Mr. Dudley, on troubles experienced with cables during the flood, I can appreciate a marked interest, which I have also noted on the part of other operating men, in rubber compounds for insulation for electrical conductors.

There has been considerable development and improvement in rubber compounds in recent years, and a wide variation in characteristics can be secured depending upon the compounding, and materials used. I think a very interesting paper could be prepared on this subject.

The design, application and installation of potheads might well be the subject of a prepared discussion, and I believe would be of interest and value to the operating men.

J. J. BOOTH: I wish to congratulate the authors of these respective papers. They have covered, in an excellent manner, the subject of reconditioning flood damaged industrial electrical equipment and, also, flood protection and rehabilitation.

The flood of March 17, 1936, will be remembered by many, especially those who suffered distress because of loss of lives, property damages, and the general disasters concurrent with the flood. When a community of thinking people endures darkness for a number of days because of the loss of electric light and power, and also suffers a shortage of water and gas, very suddenly and abruptly, they realize what flood disaster means.

I well remember listening to an extemporaneous talk made by Dr. Steinmetz in the Statler Hotel, Cleveland, in 1921, as guest speaker of our Association, when he very jokingly called the attention of his audience to what might happen at that particular moment if the power happened to go "off". The lights would go out, elevators would cease to run, street cars would stop, telephones and pushbuttons would become inoperative, and, in fact, the orderly procedure of every day life would be interrupted.

In many ways the picture as outlined was only a portion of what really happens during a major flood. We who experienced the 1936 flood learned much. Our first efforts were concentrated on keeping out the flood water, if possible, and trying to avoid a complete failure of power, and plant shutdowns. At first, as has been outlined, very few of the old timers even realized that we were in the throes of the worst disaster in the history of the Pittsburgh district. However, hour by hour, the water continued to rise; and, equally fast, the water continued to flood locations which had never been flooded before.

As the water continued to rise, all kinds and types of available equipment, such as syphons, pumps, etc., were pressed into service. Men were going hither and yon to get material and slaving to try to keep water from entering the power houses, pumping stations, blowing rooms, etc. All sewers, drains and flywheel pits, wherever possible, were plugged, and all valves closed to keep water from backing up into basements, sub-basements, checker works, etc.

Much of the lighter equipment, such as motors, transformers and controls, was moved to higher ground. It was not possible, however, to get all equipment out and up to higher ground; consequently, where this was impossible, the equipment was covered with water, silt, mud and debris. Insofar as the Carnegie-Illinois Steel Corporation was concerned, all plants along the rivers suffered more or less. Thousands and thousands of dollars' damage was done, not only because of harm to machinery, electrical and mechanical, but also because production in some plants was at a stand-still for several days, and in a few instances, for several weeks.

The flood having passed, leaving untold damage in its wake, the next thing to be done was immediately to start a general rehabilitation. In our industrial plants we had hundreds of motors, transformers and generating equipment which had been wholly or partially sub-

merged. This equipment had to be cleaned of mud, grease and slime; and after the cleaning the process of drying out followed.

The drying-out process was conducted in one of several ways. The smaller equipment was removed from foundations, taken to shops, dismantled and dried in ovens. All types of ovens were used for this drying purpose, and every available oven was used. However, the largest drying-out station was at our Homestead Works, where several of the large armor plate annealing furnaces were used for this purpose. (I might say, without exaggeration, that motors by the hundreds were put into these furnaces and dried.) The larger equipment, such as generating and sub-station equipment which could not be dismantled, was dried by one or more combinations as has been outlined in the papers of the evening, such as external heat, salamanders, steam coils, or internal heat created by passing low voltage current through windings, or by a combination of external and internal heating.

In drying out equipment damaged by flood waters, much care needs to be employed not only to prevent permanent damage to the equipment, but also to do a thorough job of the drying, in order that the equipment will stand up when put back into service. In many instances, too much haste was exercised in trying to get equipment back on the line, with the result that it was not thoroughly dried out, and, consequently, it soon broke down.

I wish to emphasize the fact that plenty of clean, dry air must be provided in the drying ovens, and this air must be allowed to escape as it becomes moisture laden, since the moist air retards and, if saturated at a high temperature, prevents the drying out process. This point was brought out very forcibly in the March, 1936 flood when many ovens of an improvised nature trapped the moist air.

We did not experience as much trouble with A.C. equipment as with D.C. With the D.C. commutators, large armatures, rotating fields, etc., considerable care and patience had to be exerted to dry out this equipment thoroughly. It also became evident that the less the commutators and windings were distributed during the drying, the less trouble we experienced.

I think every method of drying, testing, etc., brought out by the excellent papers this evening, was used, and many combinations not mentioned.

The smaller companies, and some of the larger ones, shipped a great deal of their equipment to the manufacturers for drying; in fact, I think I may safely say that the Westinghouse Electric & Manufacturing Company plants at East Pittsburgh and Homewood were drying in rehabilitation plants more than electrical manufacturers for many weeks, not only for their own equipment but for other concerns. Insofar as our own company was concerned, while we had to purchase a great number of spare parts in the nature of coils, etc., the drying out of our equipment was practically all done by our own organizations.

In closing my remarks, I will say that we all hope there may never be another flood commensurate to the one in 1936; but, from experiences this last Spring, we are led to believe that recurrent floods are possible in this district; and, while we have learned much in the way of meeting such an emergency, I think that as far as practical we should take steps to keep our plants from being flooded by the use of flood walls, levees, etc., at least until such time as the State and Federal Governments provide a flood control system. All new mills, and installations of this nature, should be designed to keep flood waters out of the basements, and if this is not possible then all electrical equipment should be installed on higher levels or kept out of basements and possible flooded areas.

Relative to equipment as manufactured by the different manufacturers, it will help materially if they will make the equipment as near water-proof as possible by the use of non hygroscopic insulating materials, non-corrosive metals and water-proof compounds.

I feel that we have had a very helpful evening from the standpoint of the papers in general, and I would like to suggest that these papers be grouped together and published, so that, when needed by any of our membership, they will be available.

JOHN KASPARI: The remark was made that a vacuum tank is the best place to dry out equipment. I would like to inquire, where is there a vacuum available in steel plants, immediately after a flood?

J. J. DURKIN: With respect to my remarks made on flood control and rehabilitation all I can offer is the discussion which followed the presentation of the papers in which Mr. Kaspari of Weirton Steel stated that one of the papers presented suggested the use of vacuum treatment in the drying out of electrical equipment. He said, he was entirely familiar with the vacuum as they knew it in the power house but did not know how the vacuum could be obtained readily on any particular location.

I suggested that any motor driven air compressor could be utilized to secure a vacuum by driving the compressor in the opposite direction.

The same compressor which furnishes us air for our shop operation is used also for securing vacuum on the treatment of lifting magnet which we received for repair. All that we do is as stated before, reverse the direction of rotation of the motor.

T. E. HUGHES: I wish to congratulate the authors of the papers presented here this evening. The subjects of reconditioning flood damaged electrical equipment, flood protection and rehabilitation have been thoroughly covered.

I was particularly interested in the problem of drying flood damaged equipment, and the papers presented on this subject are very valuable and contain a great deal of information which will be helpful and instructive in the future. The failure of some of the makeshift drying

apparatus to remove or dispose of moisture laden air was probably responsible for delays due to failure of the equipment placed in operation after it had been cleaned and dried.

Regarding the type of insulation and metals used in vital parts of relays and their mechanisms, as well as other electrical equipment, I feel that future designs should provide for the use of non-hydroscopic insulation and non-corrosive metals, in order to reduce delays after flood conditions, and for better operation in sections of the plants where equipment is subject to some moisture due to condensation, etc.

The subject of flood protection for the future presents many major problems, most of which have been covered by the various suggestions made for emergency pumping installations, drying equipment, etc., all of which require electric power, steam or compressed air. In making future plans, it is well to bear in mind that our previous experience indicates that during major floods our steam and electric power generating equipment is so located as to make it difficult to keep these units in operation, and emergency sources were also unreliable.

L. F. COFFIN: At the time of the 1936 flood in the Pittsburgh District, the resultant rise in the water level in the Chesapeake Bay near Sparrows Point was only about 6″ on account of the large area in the Bay. The menace which Sparrows Point has from floods, is due to hurricanes.

N. C. GOIN: One of the plants on the South Side thought it would be possible to prevent dirt getting into his air compressor by closing all the valves. When the water receded he found that the compressor had lifted and damaged itself more seriously than was likely to have happened had the water been allowed to enter the cylinders and pipings.

I have a good friend with the Telephone Company in the cable department who, in response to my kidding him about losing so many water-proof cables, said that it was not water that caused most of their failures, but the pressure developed by the water outside of the cable. This pressure was enough to flatten some cables, and in many cases damaged the insulation, although no water got into the cable at all. He felt that a good many leaks were caused by distortion which in turn was caused by external water pressure.

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A Modern ANNEALING PLANT For A Continuous Sheet Mill

By R. J. COWAN
Surface Combustion Corp.
TOLEDO, OHIO

Paper presented before the A. I. & S. E. Annual Spring Conference, Buffalo, N. Y., April 28-29, 1937

▲ THE successful operation of large continuous strip mills, such as the one recently completed by the Bethlehem Steel Company at Lackawanna, New York, has been attended by many problems, not the least of which was an economical method of annealing large tonnages of cold reduced sheets to meet the varied exacting specifications of discriminating customers.

It is the ABC of physical metallurgy that cold work will harden and stiffen the soft, low carbon steel utilized for this product, and also that this cold-rolled sheet can be resoftened by annealing at a moderate temperature. The crystalline grains of iron (ferrite) in the hot-rolled strip are fragmented by cold rolling, and these fundamentally disturbed particles readily recrystalize if enough heat is given to increase the atomic mobility. A rather complicated relationship exists between the degree of cold work, the annealing temperature, the time at temperature, and the resulting grain size in the recrystallized structure. Up to a limit, more severe cold work will increase the ease of annealing. The general problem of the steel mill metallurgist is to adjust the entire rolling program so that the customers' demands will be satisfied at the lowest cost. Sometimes this solution will put relatively more expense into the cold rolling department in order to cut the annealing cycle; sometimes the opposite is true. At any rate, the annealed sheet must pass close surface inspection and perform properly when stamped, drawn, welded and finished in the customers' shops. This in turn largely depends on grain size, uniformity in microstructure irrespective of direction of rolling, and freedom from internal strains and from age hardening.

Brief consideration of all these factors will indicate that the modern annealing department must not only be equipped to handle large tonnages of steel, but must be able to adjust the operations so that individual requirements may be met with certainty. This means plenty of *capacity*, *accuracy* in the heating and cooling cycle, and *flexibility* in being able to adjust this time-temperature program for each pile of sheets, if necessary. Finally annealing must be done in such a way that the surface is protected from scaling.

Further to emphasize the fact that *time* is an essential factor in such an annealing process as above defined, we may pause to note another possible heat treating operation—that known as normalizing. One essential difference between the two is that normalizing involves a heating to above the upper critical temperature of the low carbon steel, whereupon the ferrite almost instantly changes its entire crystallization system and takes the carbide into solid solution, in fact becomes an altogether new crystalline entity known as "austenite" to the metallographer. These microscopic austenite crystals also grow with increasing temperature, but the average size at any temperature depends more on the history of the steel in the refining furnace than on the cold rolling program. On cooling back through the critical range, the reverse changes take place—that is, the carbide is precipitated and the ferrite crystals are re-formed, now free of strain, and of a size inherited from the parent austenite. These crystallographic changes occur so rapidly as to be completed during a furnace heating or cooling through the critical range, and the time for normalizing in a continuous furnace is measured in minutes rather than hours for annealing in a batch-type furnace. Here is not the place to discuss the reasons why normalized sheets are not used for many deep drawing operations required during later fabrication; this paragraph is warranted in order to emphasize the fact that the "process anneal" at sub-critical temperatures is still required, and this operation takes time because it involves sluggish atomic movements at comparatively moderate temperatures.

The up-to-date method of annealing attains the old objective much more economically and surely by reason of three major improvements (a) in handling methods, (b) in heating methods and (c) in atmosphere control. In the old practice the sheets were piled on a movable base, a rather massive cover lowered and sealed around the base, the base and its load slid into a suitable furnace and heated by direct impingment of flame. A non-oxidizing gas was used to prevent scaling. In the new practice the sheets are piled on a permanent base,

a light steel "inner cover" placed over the pile, sealed at bottom and filled with a prepared gas, neutral toward steel or even deoxidizing in nature, and then a heating unit in the form of a portable furnace covers the entire assembly. The heat is generated by gas flame, but this flame, instead of circulating freely around inside the furnace, is confined inside tubes of heat resisting alloy, heating them to incandescence so they in turn form radiators. It is obvious that this arrangement facilitates the introduction of a constant supply of protective gas to the pile of sheets inside the inner cover, reduces the amount of extra material to be heated to a small proportion of the useful load, economizes greatly in cost and maintenance of protective covers, and gives a fixed source of heat placed in the most efficient position and under accurate control. There appears to be no limitation to the horizontal dimensions of the pile of sheets; vertically the pile cannot be much higher than 50 inches, else the load will cause sheets at the bottom of the pile to weld one to another.

The following is a description of a complete modern installation made by Surface Combustion Corp., at the Lackawanna plant.

The building comprises one bay of the sheet mill approximately 1000 ft. long by 100 ft. wide, and is devoted entirely to annealing wide strip steel in sheets and coils. Forty-four radiant covers, with their bases, are arranged along each side of the building, leaving a generous amount of space for a central aisle. The side walls runs up to a high clerestory above the craneway, thus providing a row of windows and ventilators just under the eaves and above the adjoining roofs.

The bases are designed in three sizes, to take sheets 75″ x 220″, 84″ x 186″ and 90″ x 250″, piled 60″ high. (All of the bases and covers can also be used for coiled strip.) The weight of a full load of sheets is approximately 100 to 135 tons.

It will be noted that these bases are solidly founded on piers and are substantial enough to take the heavy loads. Two pipe connections pass up through the base, one for entrance of prepared atmosphere, one for thermocouple leads. The inner cover is lightly braced shell, made of 3/16 common steel sheet reinforced with alloy. Its lower edge extends into a sand seal. A slight positive pressure is held on the inner atmosphere at all times and temperatures; slight infiltration of gas through the sand seal gradually fills the space between outer and inner cover and thereby protects the inner cover from all but minor scaling.

The outer covers are of the horizontal radiant tube type; the tubes are heated with a mixture of blast furnace and coke-oven gas, containing 300 B.t.u. per cu. ft., supplied at a pressure of approximately 20 oz. The mixture is carefully maintained at a constant calorific value (307 B.t.u. being the upper limit).

One one-pipe connection is necessary to the fuel gas main, the combustion gas being collected in a side downtake which connects to underground flue by an appropriate sand seal. Electric power is plugged in to drive the blower for combustion air and spent gas eductors.

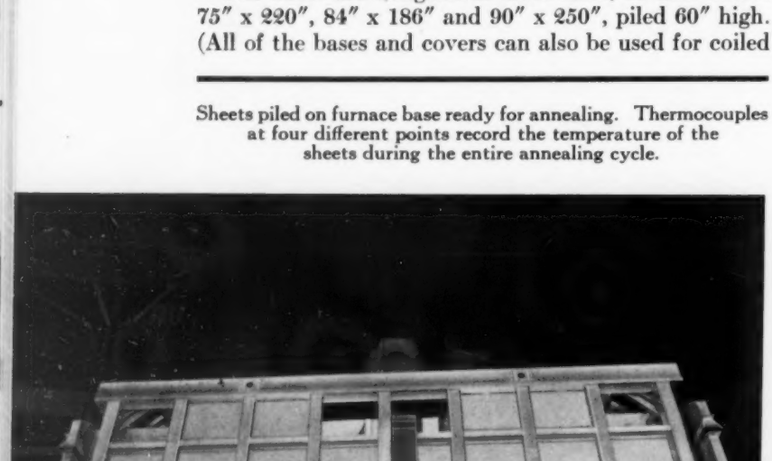
Substantially constructed of plate steel, supported by H-beam columns with all seams and joints welded gas tight, this cover is lined with light weight insulating refractory walls and a sprung arched roof. It is equipped with three tiers of horizontal U-bend heating elements. Each of these tubes has the open ends projecting through to the outer casing, and inside ride freely on brackets thus permitting full expansion and contraction to take place while maintaining tight joints in the end walls through which the ends of the tubes project.

The diffusion flame principle of heating is used for supplying heat to the tubes. As will be explained later, this method of combustion produces a long, luminous flame of controlled turbulence and heat liberation, and lends itself ideally to the internal firing of tubes. Most of the heat is generated in the two lower tiers of U-tubes, opposite the bottom of the pile of sheets. The natural upsweep of the gas filling the space between inner and outer cover brings enough heat to the upper part of the pile so that it heats from the edge toward the center at a substantially uniform rate. Obviously, it would do little good to place heaters either below or above a pile of flat sheets, since the insulating effect of the laminated surfaces would effectually stop heat transmission in a perpendicular direction.

An eductor at the discharge end of the U-tube, powered by an air blower attached to the cover, keeps the tube under a negative pressure and the suction produced at the inlet end permits the gas to unite with the required amount of air for complete combustion at very low velocity without turbulence. The flame thus procured proceeds with uniform velocity toward the discharge end of the tube. Combustion is complete within the tube.

Should a leak occur in a tube during operation, immediate repair or replacement is not necessary. It

Sheets piled on furnace base ready for annealing. Thermocouples at four different points record the temperature of the sheets during the entire annealing cycle.



can be postponed until production permits, as the tube while in operation is always under a negative pressure and the protective atmosphere can never be polluted by products of combustion.

The tests of Blaisdell, wherein many runs were made with a dozen or more thermocouples in selected positions in the pile, indicated that proper control can be had by embedding one thermocouple junction in the pile of sheets quite near a lower edge, and a second at the center of the pile well within the upper portion. As soon as the cover is lowered in place (it already being hot from another cycle) the tubes are fired at maximum rate and maintained at uniform surface temperature. Heat received by the side of the pile by radiation is conducted rapidly inward, and while the edge of the sheets reach annealing temperature first, the center does not lag far behind. In practice, therefore, the thermocouple near the edge controls heat input as soon as it reaches correct annealing temperature (say 1275°F.), and the deeply buried thermocouple tells when the annealing cycle approaches the end—the whole pile then being uniformly heated.

Two sets of supplementary fuel gas controls are used—one controlling the burners on the two lower tiers and one controlling those on the top tier. This method puts heat at a maximum rate into the work at the bottom, continuously, at the same time gradually tapers off the rate at the top until finally the top tier shuts off and the two lower tiers of U-tubes supply all of the heat the work can take without overheating the edges and causing a high temperature differential edge to center.

The tubes are made of heat resisting chromium-nickel-iron alloy castings containing about 25% chromium and 12% nickel. This analysis holds its strength remarkably well at temperatures up to 2100°F. and when exposed to oxidizing atmospheres shows no indication of surface deterioration. It is not an untried material. Heat resisting alloy parts, such as pushers, rollers and conveyors, have been successfully used in heating furnaces for a good many years with excellent results, even though they must resist severe operating conditions, successive heating and cooling, abrasion and loads. None of these duties are asked of radiant tubes, and although their application as mere heating agents is comparatively new, the life expectancy is considerably more than that of alloy parts of furnaces conveyors. Cast alloy radient tubes have actually been in operation for over 2½ years without indications of surface oxidation; apparently, replacements will not be required for a long time to come.

Controlled cooling is an essential step in correct annealing. It is obvious that this may be effected by proper manipulation of the covers. After the gas is shut off the tubes, temperature drops very slowly, since the furnace is excellently insulated. Somewhat more rapid cooling may be had by raising the outer cover a few inches and blocking it there. As a general rule, the cover is removed while the steel is up to full temperature, placed over a cold charge awaiting anneal, and the inner cover (with its contained protective atmosphere) protects the hot pile while it cools freely by radiation. An exact time-temperature curve may be secured, if such is necessary, by leaving the outer cover in place and blowing the correct amount of cold air through the U-tubes. This latter method is used for annealing black iron which is later pickled and galvanized. This is now standard practice with three steel companies using SC covers.

PROTECTIVE ATMOSPHERES

It is impossible to discuss comprehensively the chemical theory of protective atmospheres. Fortunately for process or softening annealing, the conditions are simplified by the moderate temperature of operation, and all actions are so slow at temperature below 350°F. that they have no observable effect. It has been found in practice, therefore, that almost any clean fuel gas, burned in an insufficient supply of air, will protect steel during the annealing operation if it is dried sufficiently. Given a supply of natural gas, as at the Lackawanna plant, it may be practically burned to the following analysis (dry basis by volume):

CO_2	5 to 6%
CO	9 to 10%
H_2	10 to 11%
N_2	Balance

At all temperatures up to 1300°F. a mixture of CO_2 and CO will tend to reduce any iron oxides present on steel (and therefore protect clean steel from scale) if the proportion of CO is half again as large in quantity as the CO_2. Mixtures preponderating in CO are theoretically carburizing in nature, but steel does not absorb free carbon at measurable speed until it is heated above the critical range, so we need not worry about that, and the effect of carbon oxides in this prepared gas is relatively easy to control.

The hydrogen-to-moisture ratio is a different matter. Any fuel gas high in hydrocarbons like methane, CH_4, will produce large quantities of water vapor, H_2O, on

Front view of box annealing furnaces in operation. The sand seal is plainly visible on empty base in foreground.

combustion. While a rather generous amount of water vapor in comparison with hydrogen may be tolerated in the gas at annealing temperatures (say one-third as much) without any reaction of this sort ocurring since the amount of hydrogen is sufficient to drive it in the opposite direction at high temperatures, the relative potency of the two gases changes rapidly as the temperature falls. In fact, at 350 to 400°F., which is the lower limit of activity in the cooling mass, there should be at least 20 times as much hydrogen as water vapor in the mixture, else the latter will tarnish the surface.

The practical problem is, then, to dry the prepared gas to the point where it will be innocuous, and fortunately if it is cooled to 35 to 40°F. and the condensed fog removed, the correct result is achieved.

Four gas preparation units have been installed at the Lackawanna strip mill. Each of these "DX gas machines" has a capacity of 15,000 cu. ft. of prepared gas per hour. Underneath the circular combustion chamber is located gas and air control, blowers, cooling coils for refrigerant and other auxiliaries. The natural gas and air mixture is introduced at the rear of the circular chamber lined with insulating refractories. The hot gases go through some jacketed pipe, giving up some of the heat to the cold, finished gas on the way to the annealing covers, and thence into a tower where it is sprayed with filtered water. (Clean water and clean air are both scarce articles at most steel mills.) This brings the temperature down to about 100°F. and washes out any ash; most of the entrapped fog is then cleared by passage through a second tower filled with porous tile. Gas saturated with moisture is then cooled to the required temperature (usually between 35 to 40°F.) by passing through an ordinary surface condenser, the cooling medium being any of the liquids used in household refrigerators. Condensed fog is again cleared by a baffle tower, and the prepared gas, now at 40°F. and containing only the water vapor representing dew point at that temperature, is warmed in the heat recuperator first mentioned and enters the gas mains serving the annealing department.

A word might be said of the hazards of handling this DX prepared gas. Since it is partly burned, it should be less liable to explosion and fire then ordinary fuel gas, and in fact that is so. Minor leakage around sand seals and losses from flushing an empty cover do not cause toxic effects because the carbon monoxide immediately is diluted in the air of the very large building, always adequately ventilated.

At the start of an annealing cycle, the prepared gas enters the inner cover (now containing air) and as the temperature creeps up, gradually combines with the atmospheric oxygen. Pressure is raised so considerable gas seeps out under the sand seal and enters the space between inner and outer covers, also consuming oxygen there. These actions are quite gradual.

COMBUSTION IN RADIANT TUBES

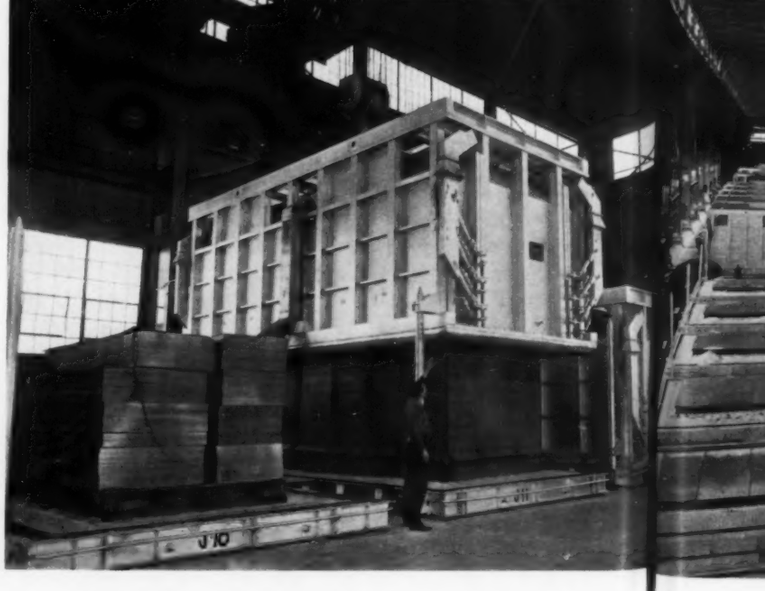
It will be observed that the radiant tube gives the advantage of an electric resistor, as regards non-contamination of the furnace atmosphere, and with a cost advantage due to the fact that a B.t.u. can be had from cheap fuel gas (even when flue losses are considered) for a lower cost than from an electric resistor at maximum efficiency. Radiant tubes, as first developed and applied to industrial heating operations by Surface Combustion Corp., derive their advantages of high thermal efficiency from the intensity of controllable radiant heat emissivity of diffusion-of-flame combustion.

The relative merits of premix burners and luminous flame combustion have been widely discussed and a confliction of statements has shrouded the facts. If gas and air are thoroughly premixed in correct proportions, combustion occurs instantaneously and the resultant heat liberation is chiefly by convection currents near the burner ports. If gas and air are not premixed, a luminous flame results as the partial or delayed combustion of the hydrocarbons progresses. In a true diffusion-of-flame combustion, gas and air are introduced into the furnace chamber in parallel layers without relative motion between gas and air which unite and burn between the interfaces of such layers so that combustion propagates at a constant rate throughout an allocated length. Therefore, the great difference between a luminous and a diffusion type flame is the rate of flame propagation, the method of mixing and the relative motion of gas and air streams. Luminous flames can be produced with any kind of commercial gas fuel; the rate of heat transfer and the composition of the flue gases are the only difference.

If radiant tubes are to be fired internally, the questions arise, "What type of flame is most suitable for the ultimate in heat transfer from the hot gases to the surrounding tube?" "Under what conditions is a diffusion type flame more efficient than a premix flame?"

To answer these questions correctly, a determination

Outer cover is placed over a pile of sheets protected by inner cover. Guide posts at corner insure proper alignment.



of the respective flue gas temperatures for the two types of combustion under the same postulated conditions as size of combustion tube, rate of gas input, wall temperature and initial air and gas temperatures will be necessary. The burner giving the lower flue gas temperature naturally will be the more efficient.

The temperature history of a premix type flame shows that a different curve is required for each rate of gas flow. This does not apply to a diffusion type flame. Its temperature will normally be lowest as it issues from the burner and will rise to a maximum as combustion proceeds within the tube, then falls again from a point near the middle to the end of the flame. By varying the port dimensions, it is possible to control the heat liberation over either short or very long flames.

If, therefore, a diffusion type flame fires a radiant tube under the same postulated conditions as the premix flame, the picture of heat distribution changes entirely. The reason is the higher heat emissivity from a radiant flame since the emissive properties of incandescent carbon particles are added to the radiation of the CO_2 and H_2O gases which are part of any type of combustion.

The energy emitted from those particles suspended in the flame has two sources, namely, from the combustion of the surrounding gases and from the oxidation of the carbon particle itself. We may safely assume that no temperature difference exists between the hot gases and the carbon particle because the heat transmission of the hot gases will be higher than the energy radiated by a single particle of carbon. In analogous manner, the total radiant energy emitted to the tube wall proper will be a direct function of the mass of carbon particles set free by the diffusion-of-flame combustion and it is evident that the flame procured has a higher luminosity than a premix type flame. Radiation from the carbon particles readily compensates for the rapid decrease in radiation of the CO_2 and H_2O gases as the flame traverses the tube, resulting in uniform heat emissivity. Since the overall heat coefficient of the flame has thus been increased, it further follows that the temperature difference between the flame and the surrounding tube wall will be less than in the case of a premix type burner.

The method of diffusion-of-flame combustion with its inherent qualities of a long, highly luminous flame, absence of turbulence, and controllability of heat liberation, lends itself ideally to internal firing of tubes. In addition to these advantages, means have been developed whereby the flame itself is always kept under negative pressure or suction, so that a small leak will not contaminate the heated furnace chamber. The operation of the tubes is very simple. Automatic temperature control devices can readily be applied. An eductor or exhauster at the discharge end keeps the tube under negative pressure and this suction produced at the burner end permits the gas to unite with the required air for complete combustion at very low velocity and without turbulence. The flame thus procured then proceeds with uniform velocity toward the discharge end of the tube.

The advent of the continuous strip mill has brought about these developments which have a far reaching effect on the process of heat treating sheets.

The box annealing building is about 1000 feet long and 100 feet wide. There are forty-four furnaces arranged along a central aisle.

DISCUSSION

PRESENTED BY

J. A. CLAUSS, Chief Engineer, Great Lakes Steel Corporation, Ecorse, Michigan.
D. E. McGUIRE, Chief Draughtsman, Great Lakes Steel Corporation, Ecorse, Michigan.
J. H. STEEL, Supt. Michigan Sheet Mills, Great Lakes Steel Corporation.
PHILIP J. BOWEN, Supt. Annealing Dept., Great Lakes Steel Corporation.
A. W. HERMAN, Lee Wilson Engineering Company, Cleveland, Ohio.
A. R. SCHULZE, Chief Engineer, Carnegie-Illinois Steel Corporation, Youngstown, Ohio.
J. L. MILLER, Asst. Combustion Engineer, Republic Steel Corporation, Cleveland, Ohio.

J. A. CLAUSS: I am sure we all enjoyed Mr. Cowan's paper very much, and I hope that the discussion which will follow will bring out some other facts.

I had an opportunity to read Mr. Cowan's paper about a week or ten days ago. We have had some experience at Great Lakes—some of it rather sad and some of it rather good. I asked our Sheet Mill Superintendent to give me an outline of his experience and he wrote up such a good analysis of his experience that I am going to present it later in the form of a paper and have another member of our organization read it.

I also spoke to our chief draftsman, who had a great

deal to do with the development of the two types of radiant tube furnaces as we know them today, and he has written a brief history which, in his absence, I am going to take the time to read, so that we can all understand some of the various steps through which this development has moved.

In submitting this information, I want to make a statement, and I want to make it emphatically, it is that we hold no brief for any manufacturer's equipment. It is necessary for us to use the various trade names to designate the types of furnaces with which we have had experience.

I want you to keep in mind also, in talking about these furnaces and giving you our experiences, that they were the pioneer furnaces and they have been vastly improved since our installation, so what I say tonight about our experience may not hold true today, but I want to recite some history here because I think this question of annealing is of great importance.

What the operating man wants to know is: Does it work? What does it cost? What are the results? Will it stand up under ordinary operating conditions? What does it cost to operate? How much maintenance is required? I have read various papers submitted on this subject in the last year and a half and I haven't found any of that information. We all know that heating steel up to a certain temperature and cooling gives a certain grain structure. As engineers we are primarily interested in the physical structure of the furnace, and the amount of fuel required to produce a ton of annealed sheets or coils.

This paper uses a lot of generalities but no definite authentic information to guide one in the selection of the proper equipment.

I am reminded of the time, when about twelve years ago at Warren we first introduced dry shafts in a normalizing furnace. A certain gentleman many of you know was interested in the talk regarding the saving in B.T.U.'s with dry shafts as against wet shafts. After listening to the arguments for days he came to my office one evening and very seriously said that he had listened for days to talk about B.T.U.'s and he wanted to know what in hell a B.T.U. was and what does it look like. I said, "Walter, if I ever catch one of these elusive B.T.U.'s I sure will hang on to it and show it to you because I've been hunting for them a long time and I never seem to be able to catch as many as the boss thinks I should".

The metallurgist always likes to talk about pearlite, crystallization and similar things way over our heads. What we want to know is: How can you get good annealing cheap? We don't care what kind of a furnace it is done in so long as the cost of the furnace is justified by the results obtained and the sheets annealed in it will process and stay with the customer.

There has been entirely too much general talk and very little concrete information upon which to base a sound decision.

Unfortunately the average sales engineer has little or no operating experience and doesn't have to live with what he sells. On the other hand, too many operators are prejudiced against anything new that they don't understand and you can't blame them much for that, because they probably have burnt their fingers more than once on a gold brick.

This question of annealing is important enough that we should pull it out in the open and freely and candidly discuss it. By a free exchange of ideas and experiences, we can get somewhere. If the operating men come here and let the manufacturer's representatives do all the talking, we are only going to get one side of the picture. The manufacturers spend their time and money preparing these papers from the information they have and it is about time the representatives of the industry be permitted to contribute to these papers and discussions. Too many come to engineering meetings with instructions from their superiors to get all they can but to say nothing. This is a short-sighted policy that has no place in this enlightened age.

I want to take exception to the statement made by Mr. Cowan that there appears to be no limitation to the horizontal dimension of the pile of sheets. In my opinion, the portable or radiant tube type of furnace has a very decided limitation in horizontal dimensions. When you handle this type of furnace made for 250 inch sheets, you are handling forty-five or fifty tons composed of a comparatively light steel shell and framework, red hot brick, expensive alloy tubes and burners which must be handled carefully. You are getting into large cranes and heavy buildings with this kind of a load, and so far as buildings and cranes go you are right back where you were when you had to lift the large cast steel Bottoms and Boxes for the in and out type of annealing furnaces.

I think you ought to take another look and not let your enthusiasm run away with you. Personally, I know I felt a lot easier in my mind when I had the 180 inch furnace than when I got a 250 inch furnace.

You gentlemen are interested in getting some facts. I will read Mr. McGuire's paper.

AN OUTLINE OF EXPERIENCE WITH PORTABLE TYPE ANNEALING FURNACES AND A BRIEF DESCRIPTION OF THE LATEST STATIONARY TYPE FURNACES INSTALLED AT THE GREAT LAKES STEEL CORPORATION PLANTS

By D. E. McGUIRE, Chief Draftsman
GREAT LAKES STEEL CORPORATION

▲ THE first portable annealing furnace for our Michigan Steel Plant was ordered on September 20, 1934, from the Gas Machinery Company. This furnace was furnished with three (3) bases and was designed by Lee Wilson having the vertical type combustion tubes along the sides of the furnace. This furnace was designed to be fired with city gas having 530 btu. per cubic foot and was arranged to anneal sheet packs 76″ wide by 144″ long by 58″ high without inner covers.

This furnace was received October 6, 1934, and the first heat began November 27, 1934. It is our belief

that this was the third furnace of the radiant tube type ever built for sheets. We ran nine (9) heats without inner covers and our first inner cover was designed November 14, 1934. The first heat in this furnace was run with an inner cover December 27, 1934, and we believe that this is the first inner cover designed and used on this type of furnace.

The second furnace with three (3) bases and without inner covers was purchased September 26, 1934, from Surface Combustion Corp. This furnace was designed to be fired with city gas having 530 btu. per cubic foot and designed to handle 76″ wide by 144″ long by 58″ high sheet packs without inner covers.

This furnace was received November 18, 1934, and the first heat began December 5, 1934. This was the first furnace of this type built for sheets by the Surface Combustion Corp. The furnace was equipped with horizontal combustion tubes and each tube was L-shaped extending from one corner of the cover across one end and one side wall, thus heating the ends as well as the sides of the sheet pack. This furnace was equipped with inner covers after the fifth heat on January 9, 1935.

Both of the above furnaces were later equipped with an additional base, making four (4) bases for each furnace and four (4) inner covers for each furnace. Our experience with these two furnaces indicates that the horizontal tube design is much superior to the vertical tube type, since the horizontal tube type furnace was more efficient in the use of fuel and easier to control. Lee Wilson has done a good job and deserves a great deal of credit for what he has done. He was the first furnace engineer who had the nerve and foresight to step out of the beaten track and design a box annealing furnace radically different from what we had been using. For many years we seemed to act as if nothing more could be done with box annealing furnaces. Since Wilson first startled the industry with his radical departure of box annealing furnace design, more thought has been given to box annealing than this operation received the previous forty years. I want to make public acknowledgment for the contribution this engineer has made towards improving box annealing. As stated previously, we installed the third Wilson vertical tube box annealing furnace. I understood that this furnace has been considerably changed and improved in later installations. We might also add that the design of the horizontal tube furnace was much more rugged structurally than the vertical tube type and that the maintenance cost on the horizontal tube type has been consistently less than on the other type of furnace.

The third furnace with four (4) bases and four (4) inner covers was purchased August 8, 1935, from Surface Combustion Corp., and was received October 2, 1935. This furnace was designed with horizontal tubes of the hairpin type and was fired with No. 2 furnace oil. This unit was arranged to handle sheet packs 75″ wide by 156″ long by 58″ high.

The fourth furnace with four (4) bases and four (4) inner covers was a duplicate of the third furnace. It was purchased from Surface Combustion Corp. on November 11, 1935, and was received on December 23, 1935. That was also an oil-fired radiant tube.

Both of these oil-fired furnaces operated satisfactorily on No. 2 furnace oil, but, when No. 3 furnace oil was substituted, burner trouble developed and it was necessary to make certain burner alterations in order to accommodate the heavier oil.

Furnaces Nos. 5, 6, 7, and 8, each with four (4) sets of bases and inner covers, were purchased August 7, 1936, and erection completed December 9, 1936. These four furnaces were also oil-burning. These furnaces were equipped with the hairpin type tubes, with burners and tubes arranged on each side of the furnace and one row of tubes in the center.

The furnaces were designed to accommodate four (4) packs of sheets 52″ wide by 120″ long by 58″ high, each pack of sheets protected with a separate inner cover; or two (2) packs of sheets 52″ wide by 250″ long by 58″ high with a long inner cover over each pack. Thus far these furnaces have been operating with four (4) packs of sheets per furnace. We never had occasion to put a 250″ sheet in those furnaces.

The furnaces operated satisfactorily with No. 3 furnace oil until a poorer grade of oil was received, at which time burner trouble developed. Also burner trouble developed on Furnaces Nos. 3 and 4 at the same time, and at the present writing all of the burner equipment of Furnaces Nos. 3 to 8, inclusive, is undergoing revision to take care of the poorer grade of oil.

We have found from our experience with the portable type furnaces that the principal source of trouble and maintenance lay in the design of the bases and inner covers. The first bases were of flimsy design, with the inner cover sand seals fabricated of steel plate. The latest design of bases is more sturdy and the bases are constructed of heavy cast iron sections with sand seals formed in the brickwork of the bases. We have found that the maintenance on this latest design of bases amounts to practically nothing.

We have also experimented with numerous types of inner covers. The first inner cover was built in our shops and was constructed of an inner bar frame over which was stretched a 11-gauge sheet steel envelope. This type of inner cover is still in use in our plant, although the sheet steel envelopes have been replaced and considerable welding must be continually performed in order to keep these covers gas tight. Other types were tried out, but the inner cover constructed of 3/16″ thick corrugated side walls with a reinforced crowned roof has proved most satisfactory in service. All of the material used in these corrugated type inner covers is mild steel.

Experimental work had also been carried on with light covers for the old in-and-out stationary type furnaces at the Michigan Steel Plant in order to reduce the gross weight of the charge in these old type furnaces. In 1934 we negotiated with the Babcock & Wilcox Company for the purchase of the light weight cover to replace the heavy cast steel covers used in the old type furnaces. We purchased from the Babcock & Wilcox Company in May one light weight cover for 70″ wide by 144″ long sheets. I want to bring that point out because there is a little dispute about this cover business. This cover was constructed of a welded inner frame of cast steel over which was stretched an envelope of 11 gauge heat-resisting alloy sheets. The

weight of this cover was about 5000 lbs. against 10 tons for the weight of the old cast steel covers. By the reduction of the weight in the cover we were able to load the annealing bottoms with more sheets without overloading the cranes operating in the Annealing Department.

This cover has now operated for 80 fires, and a recent inspection showed it to be in practically as good a condition after this number of fires as when it was originally installed. Only four (4) welds have been required to keep this cover in gas-tight condition. We feel that the use of light covers, either of the corrugated carbon steel type or the combination of steel and alloy, increases the efficiency and effectiveness of the stationary type furnaces, and all future covers for this type of equipment will be of this light construction.

We now have on order with Surface Combustion Corporation for our Great Lakes Steel Plant Annealing Dept. Extension six (6) sheet and two (2) coil portable furnaces.

The sheet furnaces are designed to handle 90″ wide by 250″ long by 58″ high sheet packs. The coil furnaces are designed to handle eight (8) coils 48″ O.D. by 104″ high. These furnaces will be gas fired. They are to start operation with natural gas and later changed to coke oven gas or mixed gas fuel. Our fuel situation has changed since about a year and a half ago, and in the next few months we will have an abundant supply of coke oven gas. Detroit now has natural gas instead of manufactured gas, which has higher btu. content and lower price, so we are going to start with furnaces with natural gas and put them on coke oven gas later.

The coil furnaces are designed with the center row of tubes and have fans in each coil base which will facilitate the heating and cooling of the coils.

At our Great Lakes Steel Plant we now have installed and operating five (5) batteries of stationary type furnaces. The reason I am going to tell you this is that later on, when we read this other paper, we are going to give you some facts about tonnages. Each of these batteries is made up of four (4) holes each. These furnaces were built by the Rust Furnace Company. Each furnace has a depth from front to rear wall of 27′ 6″ and is wide enough to receive a 10-ft wide bottom.

These furnaces are located in a leanto on one side of a 100-ft. wide annealing building. They are served by a Mesta charging car operating on a depressed track along the front of the furnaces. On the opposite side of the car track from the furnaces are located the cooling racks arranged parallel with the furnaces. The support for the annealing bottoms on these racks consists of balls and rollers duplicating the equipment that is in the furnaces. The new radiant tube furnaces will be put in the building that is an extension of the main annealing building. We are going to keep the same type of building, but eliminate the leanto and put the radiant tubes out in the center aisle.

Sufficient cooling racks have been installed to handle the cooling and charging of the material to be processed in the furnaces. Between the racks and the building wall opposite the furnaces is left a space which can be used either for trucking material up and down the building or as storage for material or spare annealing equipment. Material is taken in and out of the furnaces and stored and loaded on the cooling racks and handled by the charging car entirely.

The furnaces are at present fired with heavy fuel oil. Combustion takes place in burner tunnels, one tunnel on each side of each furnace chamber. Each tunnel is fired by two (2) burners, one located in the front and the other in the rear, making a total of four (4) burners per furnace.

The design of the furnace bottoms is such that at any future time these furnaces may be converted to gas firing.

The furnaces have been installed with a cellar running the entire length of the batteries. I believe this is the first box annealing furnace that has this type of construction. Many of you gentlemen saw it last September. You probably noticed there were no pipes or fans or anything on the floor. Our conditions there are that we have to pile everything, and as long as we are down about seventeen feet, we decided we would cap the piles with a heavy mat and build up some walls and set the furnace on beams resting on the walls and use the intervening space for a cellar. It works out very beautifully. The fans, fuel oil equipment, and piping are located in this cellar and are out of the way. The cellar also provides for a flexible base for the annealing furnaces which takes care of all expansion in the structure.

These furnaces have proved economical and efficient in operation since their installation.

The in-and-out type of furnaces above described have produced a monthly tonnage of approximately 22,000 tons of sheets and coils, with an average fuel consumption of 9¼ gallons of heavy fuel oil per ton of steel annealed.

J. A. Clauss: There is one remark I want to make. These radiant tube salesmen come around and tell us, and they are right, that they will anneal heats for one million B.T.U. per ton and they compare this with the old style of furnace which consists of a pile of brick and a couple of channels, what we used to call an annealing furnace. We have found that a properly designed in-and-out type, insulated box annealing furnace has a fuel consumption just as low as the radiant tube type if you use it rightly. So it isn't quite a fair comparison to talk about 17 or 18 gallons of oil or its equivalent in heat and then stack up alongside it a 1937 model radiant tube furnace. Some of these old box annealing furnaces were built twenty or twenty-five years ago and are just a pile of brick today compared with the modern design.

I don't know whether you fellows want to hear anything more about what we are doing or not. I have another paper here I would like to ask Mr. Mayberry to read, if you are interested. I didn't intend to do all this. Shall I read it or have it read?

It will tell you some of the experiences we have had in the way of tube failures and some of the grief that we operating men have in trying to put some of these things across.

Mr. Mayberry is the Superintendent of our new Cold Strip Department, and he is going to read this paper. He is not entirely in accord with it. He is an

operator who has his own ideas and he is privileged to have them. Yet he is gracious enough, in the absence of Mr. Homer Steels, to read this paper.

What we want to bring out tonight, if we can, is these divergent viewpoints. I hope some good will come from it. We will give you our experience, and we hope that we will get some experience from you fellows.

RADIANT TUBE BOX ANNEALING

By J. H. STEELE, Superintendent
Michigan Sheet Mills
GREAT LAKES STEEL CORPORATION

▲ IN October 1934, the writer witnessed the installation of a radiant vertical tube box annealing furnace for city gas (530 B.T.U.) fuel. There were four bases provided for each furnace of suitable size to accommodate flat sheets 75″ x 144″. Previous installations elsewhere had been for natural gas as fuel and common iron grades. Our product was cold roll grade produced on two-high hot mills. Our task was to box anneal normalized pickled sheets at 1150 to 1175° F. to produce physical tests of suitable standards for the automobile body trade. We anticipated 800 to 850 tons production per month with a 42 hour cycle for heating, soaking, cooling, and transferring the furnace to another base. The installation included a DX Unit of suitable capacity to envelope the charge from start of period to the end.

A horizontal radiant tube furnace for 530 B.T.U. fuel was installed almost simultaneously with the vertical tube furnace for the same task and the same anticipations were held for it.

At this time we feel a brief description should be made of the existent box annealing furnaces. Our department consisted of 14 furnaces for 48″ wide maximum, 4 for 58″ wide maximum, 4 for 72″ wide maximum, and only 2 for 75″ maximum width of the in-and-out type built for hand fired coal as fuel and converted to burning oil of 16 to 18 Be. The covers were cast steel and the charge was pushed into the furnace with a pole and pulled out with cables. Our cranes were taxed to lift pots of sufficient size to effect economical operations. No floor space was available for construction of any more furnaces of the in-and-out type. The radiant tube looked like an escape from the sand nuisance and cumbersome method of thermo-couple installation and the scientific construction of the furnace warranted less radiation loss.

Early in February 1935, we had 21 charges (1204 tons) from the vertical tube furnace using 2320 feet of gas per ton, while the horizontal tube furnace had 15 charges of 741 tons using 1967 feet of gas per ton. In comparing these two furnaces we expressed a preference for the horizontal tube for three reasons which have been confirmed by experience to date.

In the first place, the horizontal tube furnace is of more sturdy mechanical construction and superior tube design. In the second place, the horizontal tube is more economical in fuel consumption. In the third place, the horizontal tube furnace is more flexible for pile arrangement, the distribution of heat is superior, and requires less attention to operate.

By this time inner covers had been introduced in the operation. Of these we had two. One type was constructed of 3/16″ corrugated low carbon steel sides and ends with a flat semi-reinforced top. The other type was constructed of flat low carbon steel plates welded over a standard steel framework. Both types of covers rested in a rolled steel gutter welded to the edge of the base plate. Various types of construction were tried without success in this suspended seal. The introduction of DX gas and the thermocouples complicated the construction and every idea to offset warpage of the seal was fruitless. The bottom plates and bottoms warped badly and caused stickers. To maintain the bottoms and sand seals for the inner covers required bricklayers, welders, and mechanics in constant attention. The corrugated inner covers would average 53 fires before needed repairs, while the flat steel covers over a rib framework required repairs on every other fire after a total of 20.

Inner covers were made necessary for us for two reasons. The first one being to remove the necessity of pickling after box annealing, and the other to release the furnace after completion of the firing and soaking cycle. In the old-style box anneal the furnace would be tied up for 68 to 70 hours for a 70″ pot, while we found the radiant tube furnace tied up on 70″ wide for 35 hours firing, 3 hours soaking, and 100 hours cooling. We have stated that we anticipated a 42 hour total cycle for a charge and in practice used a 138 hour cycle. Inner covers increased production by releasing the furnace after the soaking period to start on another charge.

By March of 1936 we had 256 charges from the vertical tube furnace and had replaced 30 tubes. Cast iron burner tips had been replaced with alloy tips to reduce tube failures and these in turn had been replaced with refractory alloy tips to reduce the terrible squealing and deafening noise if the burners were set for the most economical adjustment for fuel consumption. The furnace had sprung out at the bottom and it was necessary to place a heavy boxing on each side above the manifolds and clamp securely with stay bolts. From the horizontal tube furnace we had 267 charges and no repairs on either tubes or furnace.

By February of 1935 we annealed 745 tons in the vertical tube and reached 1100 in July and averaged 870 tons per month for the year. Production did not warrant continuous operations in 1936 until October and this will be taken up later. By February of 1935 we annealed 699 tons in the horizontal tube and reached 1138 tons in March and averaged 930 per month for the year. This furnace operated more in 1936 than the other furnace due to reasons before stated.

By October of 1936 our trend of orders was such that it was mandatory to increase our box anneal production, and we were cognizant of the fact that natural gas would replace the 530 B.T.U. gas. This change was made in November of 1936. In 1936 we were confronted with another change and that was the task of annealing cold reduced strip steel. We found it necessary to reach a temperature of 1240° F., an increase of 90° F., and increase the soaking period of 16 hours,

making an increase of the complete cycle for 70″ wide of 19 hours. The trend of sizes along with the firing conditions reduced our tons per pot from 50 to 40, and for the past five months the vertical tube furnace has averaged 491 tons per month and a fuel consumption of 1835 feet per ton. The horizontal tube furnace operating under the above conditions averaged 546 tons per month and a fuel consumption of 1473 feet per ton. Our inability to reduce the apparent loss of production without running the hazard of grain growth adjacent to the tubes and the never-ending repair to seals and bases caused the writer to lose some enthusiasm for radiant tube box annealing.

In October of 1935 we installed a 3″ horizontal tube furnace using 32-36 Be. oil for fuel. In January of 1936 we had another oil burning radiant tube furnace ready for production, except the tubes were 4″ instead of 3″. These furnaces with 2-high hot rolled product would anneal 850 tons each per month at 9 gallons per ton. These furnaces, like the gas ones, became objects of criticism when production demands were great. In the past five months on cold reduced strip these furnaces have averaged 558 tons at 11 gallons of oil per ton. In twelve months we repaired the tubes 12 times on the 3″ design and only twice on the 4″ design. Both furnaces are now equipped with 4″ tubes. These furnaces have performed as anticipated regarding fuel consumption. The sand seals for inner cover suspension and base repair are with us yet. We have one cast steel base incorporating the sand seal which is symmetrical on both sides permitting of reversal at regular intervals to offset warpage. This base is very practical and an improvement over any base design at time of installation, but inferior to the one of our own Michigan conception and design.

In November of 1936 we installed four horizontal tube oil fired furnaces of the multiple base type. A furnace covers four bases 52″ x 120″. The radiant tubes are in series of three dividing the furnace in two compartments to cover two bases 52″ x 250″ side by side. These four furnaces were rated at 6800 tons per month and we have averaged 6230 tons at 10 gallons a ton.

In the five months that these four furnaces have been in operation there has been no repair to sand seals or bases. These bases and sand seals evolved from the experience of the operators. In January we encountered serious difficulty in combustion. A change was made in the source of oil of the same grade with disastrous results. It was evident that the burner would not atomize and burn all oils in the distillation range of one grade. This oil situation was the result of heavy domestic demand. The furnaces became sluggish and the burners required constant care with repeated dismantling and cleaning. Cranemen were almost driven from their cabs by the fumes. The research for burner adjustment went on and the Operating Department made the best of a bad situation. Sleeves were consumed and six tubes from a total of 48 had holes burned through, usually at the welds. These tubes are 4″ and 5″ diameter. The most important factor which governs tonnage production is the degree to which the bases are filled. The soaking time and the interval consumed in transferring the furnace to another base remain constant. It, therefore, follows that production reflects on the operating departments due to the range of orders, as well as their own and furnace efficiency.

The writer has been on the scene through the pioneering stage of radiant tube annealing of cold rolled sheets produced both by hot and cold rolled reduction. It has been found necessary to increase the degree of heat, also the time exposure, for cold reduced sheets over hot rolled. We have found that the quality of work performed by radiant tube annealing to be equal to that performed in our old-style box anneal. We have observed that there is a distinct tendency for stickers in radiant tube annealing. This can be accounted for by the fact that the warpage on our bases has been severe. In addition we have filled the pots in height in an effort to get tonnage, and the increased pressure on the bottom lifts has caused stickers. In our old box anneal we were limited by crane capacity and the pile of steel in the charge seldom exceeded 44″ for wide, long stock. In the radiant tube anneal we have piled stock as high as 57″ and have now reduced it to 52″. We are hopeful that conditions will warrant our holding the overall height to 48″.

Our DX gas in radiant tube annealing has given more consistent results than that obtained in our old-style box anneal. Within the last 24 hours we broke four bases in which we had used DX gas cooled indirectly, and three bases of the four were perfect while the fourth one had an accumulation of soot. We feel that this fourth base was not bled sufficiently to permit the smoke to get out.

As is the usual experience in the development of any new innovation, there remain a great many troublesome factors which time and experience alone will reveal and correct. Since we have had both vertical and horizontal tube furnaces for gas and two different types of gas, together with three different types of oil-fired horizontal tube furnaces, we feel that the grief which has been present with this development in the combustion of oil, with bases, sand seals, inner covers, and DX gas may prejudice our conception of their true value. We have gotten away from the sand nuisance and it is much easier to install thermocouples than the old-style box anneal. At Michigan we could have installed additional box anneal equipment of no other type and we do not regret our choice.

If comparison is made of radiant tube annealing with box annealing of modern design and good construction, it might not favor the radiant tube design. However, in the light of our present ability to burn oil in our oil-fired radiant tube furnaces, we are encouraged and feel that from an operating standpoint they are practical. In comparing the cost of operations of these furnaces with furnaces of modern design and good construction, we find our cost to be much higher. A fair between annealing of this kind and that done under our conditions will take into account that our furnaces are located under two different cranes, in two different buildings, and the total tonnage possible for us to anneal can be considered only a small department with a lot of overhead.

Since it is not expedient to provide oil of a suitable distillation range for all seasons of the year, we would recommend that radiant tube annealing be confined to

the use of gas if the same can be provided in good cost.

We don't feel that our experience to date from the standpoint of cost reflect the ultimate in radiant tube annealing for we have had a great amount of repair work. We feel that a lot can be accomplished with the co-operation of furnace designers, engineers, and the Operating Department.

RADIANT TUBE ANNEALING

By PHILIP J. BOWEN
Supt. Annealing Department
GREAT LAKES STEEL CORPORATION

▲ IN the term "Box Annealing" four factors must be taken into consideration—Time, Temperatures, Grade and Uniformity of Material. One must also know that Box Annealing is a slow-firing and slow-cooling process. In other words, nature must have its own course where these factors enter in. Not one of these can be neglected.

Radiant Tube Annealing Furnaces, the latest type of Box Annealing equipment, introduced into the Steel Industries within the last few years, have some commendable features:

First: Initial cost of installation.
Second: Space required for installation of same.
Third: Its more rapid firing cycle (over that of the old type, in and out, *coal* and *gas fired* furnace) by the application of from twelve to twenty-eight burners used for burning fuel oil, natural or artificial gas.

Radiant Tube Furnaces are adaptable to artificial or natural gas and fuel oil, either of the former preferable, owing to the fact that a better control of cycle is maintained and less supervision required, owing to the fact that when burning fuel oil with the present set-up, considerable trouble is encountered, especially on low setting by carbon deposit on side of burner housing and at entrance to tube or sleeve causing burner to spit and go out. When this condition exists a great temperature differential is experienced owing to furnace construction.

The tubes are only about $\frac{3}{8}$" to $\frac{1}{4}$" in thickness and the flow of air passing through while burners are out causes rapid cooling.

The wall, constructed of insulating brick, does not absorb and maintain heat such as fire brick in old type, in and out, Box Annealing Furnaces.

Considerable time and attention is required when fuel oil is used, for the purpose of cleaning and adjusting burners. A furnace with from eight to ten burners, which sometime goes out every thirty to forty minutes, needs constant care. Such has been our experience with the latest installation. Such a condition does not exist when using gas for fuel. Yet the use of gas in some localities is almost prohibitive from the standpoint of operating cost, which is approximately eighty-five to ninety-five cents per ton, where fuel oil is not quite half.

Firing Cycle and Relative Temperature:

A greater number of burners, which mean a more equal distribution of heat has had a tendency to give a more rapid firing cycle over the old type of gas and coal fired, in and out, Box Annealing Furnace, with the added effect of the Radiant Tubes placed within six or seven inches from the side of the piles. This factor is to be questioned because of the fact that tube temperature from 1400 to 1450 degrees Fahrenheit has a rash or punishing effect on the side of the pile, which from a metallurgical standpoint creates heat waves in the steel.

The writer realizes that this is the age of speed and production is the paramount issue when cost is the main factor in all phases of industry.

Yet when normalized and cold reduced steel sheets are fired beyond a certain rate of penetration, there is a danger of un-uniformity of grain structure and also a greater relative difference from top to bottom and side to center of the pile. In many instances thermo couples, placed in the center of the pile and one inch inside of the pile have had a differential of from 150 to 200 degrees when brought up too fast, with a difference of from 75 to 100 degrees from top to bottom. Steel will absorb heat from side to center only so fast and one must strike the happy medium of uniform penetration and not exceed that point. He will therefore not only have uniform softness or Rockwell, but also obtain uniform structure from side to center and top to bottom. The writer from present experience of annealing with in and out type, insulated oil-fired furnaces with cycle of from $1\frac{3}{4}$ to $2\frac{1}{4}$ tons per hour, has a relative temperature of from 30 to 50 degrees top to bottom. (Insulation and two added burners, more scientifically applied have given this result over old type Box Annealing, with oil consumption of about eight and nine-tenths to nine and one-half gallons per ton. One man handles eighty burners on twenty furnaces with perfect ease, no carbon trouble of fluctuation whatever.)

Soaking Period:

In Box Annealing after the required maximum temperature is reached the greatest asset is to maintain that peak temperature as near as possible until the furnace is lifted or the doors are opened. Therein, uniformity of Rockwell and grain is obtained. On the Radiant Tube Furnaces it has not been possible to do so. After a few hours, couples start to drop. To overcome that, the lighting of burners has been necessary.

This condition is brought about by the fact that insulating brick does not absorb and retain heat, but reflects or retards loss of heat through furnace walls. Therefore it cannot give heat to the pile of steel after burners have been shut off.

On the other hand on our new in and out furnaces, if we desire a 1240 degree temperature, we fire to 1220 or 1230 degrees, shut off the burners, lower the damper, and the pile receives heat from saturated furnace walls and couples, and coasts up to 1240 to 1250 degrees, which is a very desirable condition in heat-treating, normalized, and cold reduced sheets. This reduces the possibility of stickers and grain growth to a very great

degree, and tends in the soaking period to give a much desired condition of uniformity of product and maximum ductility.

There is no comparison that can be justly made between the old in and out furnaces of about ten to fifteen years back and the Radiant Tube Furnace. Yet there is a very close comparison between Radiant Tube Furnace and the new insulated oil-fired, in and out, Box Annealing Furnace of today.

J. H. STEELE: We have read the paper by Mr. Cowan of the Surface Combustion Corp. and we feel he has given a very worthwhile discussion from an academic standpoint. We note that he recommends the height of the pile to be 50″, while he states that Bethlehem pile 60″ high. It is out opinion that Bethlehem will have a lot of stickers. The writer injers that the inner covers are subject to only a slight oxidation and that the DX gas which has filtered through the inner cover sand seal protects the cover from the radiant tubes even if the tubes spring a leak. It is our experience that these inner covers scale rapidly and that the DX gas is not adequate to protect the cover if the tubes spring a leak.

It is particularly significant to me that Mr. Cowan makes no reference of any kind to the fact that we have six furnaces of Surface Combustion construction operating with oil as a fuel. This begs a question in my mind. That question is, why does he omit oil as a fuel when there must certainly be sections in the country where gas is not available– The paper by Mr. Cowan is particularly gratifying to me since he confirms my estimation of radiant tube annealing if gas is used as a fuel. Since his paper is academic in nature, I am disappointed that he did not make some allusion to the transfer of heat based on the number of square inches of the tubes. It is my opinion that the tubes in radiant tube furnaces should be larger in area, and if possible, slightly further away from the work than the furnaces in our operation here. I expected that he would give some ratio for the heat units from each square inch or square foot of area from the tubes. It is my contention that the tubes should be a little larger than even the largest tubes of our latest installation so that it will be possible to radiate in a unit of time more heat units than we do and still not increase the degree of heat. This contention can be reached by enlarging the tube which increases the area from which heat is radiated and also by widening the furnace so that the source of heat is a little further away from the work. I realize my limitations in technical education to say where this increase in tube size or width of furnace is to be, but I do believe that this is a basic principle which technical men should clarify. To make myself clear I wish to state it in these words: For a 3″ tube to radiate a given quantity of heat it would be necessary for the degree of heat to be much higher than for a 5″ tube to radiate the same given quantity of heat.

I infer from Mr. Cowan's paper that the salvation of DX gas is in its generous use. I have only a few facts to base my contention, but I am of the opinion that the least amount of DX gas used to prevent the infiltration of oxygen to be the better practice. At the present time we are running an experiment to clarify this point.

There is one other point which I feel Mr. Cowan has not adequately covered and that is the absolute necessity that the pots be bled sufficiently. Cold reduced strip is rolled in oil, and with the number of square inches in a charge there is an appreciable amount of oil containing carbon which must be disposed of and can be removed only if adequate facilities are provided for proper bleeding.

J. A. CLAUSS: I can tell you right now that I haven't time to come down here and just waste my time. I know that every one of you fellows in the operating department was sent here at your company's expense to get some information. I think the object of this organization ought to be to spread information. I don't think we ought to be afraid to talk about it. We have to do a little educational work. There are some things we can't talk about, which the policies of our companies do not permit our talking about, but there are a lot of things we can talk about which will be of natural interest and benefit to all of us.

My people have graciously permitted me to divulge our experience here in the hope that we will clarify this situation. We are going to keep on buying annealing equipment. I am trying to find out what is the best annealing equipment, but I am not going to stop there. I have to reduce costs.

I think all of you fellows—you engineers, heads of construction departments, and particularly you operating men—ought to get up here and take an active part in this thing. If we are going to make this Association take its rightful place in the steel industry we have to do some real work.

I have been hoping that in the near future the Association of Iron and Steel Engineers becomes the technical branch of the Iron and Steel Institute. The gentlemen who go to New York for the Institute meetings are generally the higher executives primarily interested in the economics of the business who do not have the time to sit and listen to technical papers. I think that is our function, and I am hoping that we can make the standard of this Association so high that we will have the full confidence of our superiors and that we will be permitted to exchange ideas freely and candidly for the good of the whole industry. That is what we are trying to drive at and we would like to have some help.

I think if you gentlemen go home and talk about that along these lines we will get some place.

A. R. SCHULZE: We haven't had any experience with annealing—that is out of our scope so far—but I want to commend the broad nature of the discussion of the paper. I think it is a definite stride forward to have discussions of this sort. While this is a little new, if you look at it from the broad scope, as you have tonight, I think it should be a trend and will very much amplify the value to be obtained from these meetings.

A. W. HERMAN: I would like to say a few words about tube type annealing.

As Mr. Clauss pointed out, his experience with tube type annealers has been on pioneering furnaces, and

he has given a very complete story of what happened at Great Lakes. I was there myself, and every bit of it is quite true, but I want you to remember we have all made improvements on our tube type furnaces. Like any pioneering development there are always little details that have to be changed from time to time as the units are put into operation. We have constantly been bringing the Wilson tube type furnaces to a perfected design, whereby it is being widely accepted by the industry. This situation is analogous to the present day automobiles and radios with those of only a few years ago.

The Chairman tried to get some of the later buyers of these furnaces to talk, but no one did. I believe that would be a fair test on the tube type furnace. As Mr. Clauss pointed out, you can't take the sales engineer's word for it. You have to get the information from the users. The present-day users are the ones who can tell you the comparative records of the makers of tube type furnaces, and we will just have to leave it up to them.

J. L. MILLER: I, too, wish to add a word of compliment to the open discussion of this subject which the Great Lakes people have prepared.

At Follansbee Brothers Company, Toronto Works, the first two Dressler continuous annealing kilns for automobile sheets were put in operation in 1922. These kilns were heated on the radiant principle by means of refractory mu#es fired with clean producer gas. I have often wondered if the radiant tube annealing had its origin in the results obtained on such kilns but overcoming the operating handicaps.

Association Activities

CHICAGO SECTION

January 18, 1938—6:15 P.M.
PETER LEVANT'S RESTAURANT
1247 Calumet Avenue
Roby, Indiana

"*A Study of Stress Distribution—Illustrated by Means of Rubber Models and Celluloid Models*" by E. W. P. Smith, Consulting Engineer of the Lincoln Electric Company, Cleveland, Ohio.

H. W. NEBLETT, Chairman
A. J. WHITCOMB, Secretary

CLEVELAND SECTION

January 10, 1938—8:00 P.M.
CLEVELAND ENGINEERING SOCIETY
Guild Hall, Midland Building
(Terminal Group)

"*X-Rays, Radium and What Next?*" by John D. Leitch, Development Engineer, Electric Controller and Manufacturing Company, Cleveland, Ohio.

T. J. Ess, Chairman
W. W. SPANAGEL, Secretary

PITTSBURGH SECTION

December 17, 1937—6:30 P.M.
CARDINAL ROOM, WILLIAM PENN HOTEL

"*High Voltage Transmission Lines and Towers as Relating to Steel Mill Requirements*" by E. L. Peterson, Transmission Engineer, American Gas and Electric Company, New York, N. Y.

Added Feature: Movies of the 33rd Convention and Exposition of the Association will be shown at the conclusion of the meeting.

T. E. HUGHES, Chairman

PHILADELPHIA SECTION

January 8, 1938—6:00 P.M.
ENGINEER'S CLUB
1317 Spruce Street

"*Flow of Metal Between Rolls*", by Louis Moses, Superintendent of Rail Mill and Roll Department, Bethlehem Steel Co., Sparrows Point, Maryland.

G. O. VAN ARTSDALEN, Chairman
LINN O. MORROW, Secretary

BIRMINGHAM SECTION

January 31, 1938—6:45 P.M.
THOMAS JEFFERSON HOTEL

"*Birmingham's Industrial Water Supply System*" by A. C. Polk, Executive Engineer, Birmingham Industrial Water Supply System.

R. R. THOMAS, Chairman
BIRGER THELE, Secretary

ANNUAL SPRING CONFERENCE

Thursday and Friday, April 28 and 29, 1938.
LORD BALTIMORE HOTEL
Baltimore, Maryland

The Spring Conference will include two technical sessions with six papers and discussion, and an inspection trip to the Hot and Cold Strip Mills at the Sparrows Point Plant of the Bethlehem Steel Company.

A. I. & S. E.

ASSOCIATION OF IRON AND STEEL ENGINEERS

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President,
Woodward Iron Company,
Woodward, Alabama.

HARRY A. BOLE,
Chief Staff Engineer,
Carnegie-Illinois Steel Corp.
Pittsburgh, Penna.

CLIFFORD R. FOX,
Superintendent
56" Hot Strip Mill,
Bethlehem Steel Company,
Sparrows Point, Md.

JAMES R. CUMMING,
Electrical Engineer,
Tennessee Coal, Iron & R. R. Co.
Fairfield, Alabama.

R. L. DOWELL,
Electrical Engineer,
Tennessee Coal, Iron & R. R. Co.
Birmingham, Alabama.

A. B. DUNNING,
Engineer,
Tennessee Coal, Iron & R. R. Co.
Birmingham, Alabama.

H. A. HOEHN,
Draftsman,
Tennessee Coal, Iron & R. R. Co.
Ensley, Alabama.

E. J. HOUBAER,
Superintendent,
Metallurgical Works,
John Cockerill's Company,
Serain, Belgium.

F. F. MCCLURE,
Slab Checker,
Blooming Mill Department,
Otis Steel Company,
Cleveland, Ohio.

ANDREW MALONE,
Electrical Draftsman,
Tennessee Coal, Iron & R. R. Co.
Fairfield, Alabama.

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Youngstown, Ohio.

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East Chicago, Indiana.

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Ensley Works,
Ensley, Alabama.

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Engineering Department,
Tennessee Coal, Iron & R. R. Co.
Ensley Works, Birmingham, Alabama.

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Carnegie-Illinois Steel Corp.
Gary, Indiana.

R. H. TURNER,
Engineer,
Electrical Department,
Carnegie-Illinois Steel Corp.
Chicago, Illinois.

CALVIN WHITFIELD,
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Birmingham, Alabama.

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Sales Engineer,
I-T-E Circuit Breaker Co.
Cleveland, Ohio.

M. A. DUBOIS,
Chief Engineer,
Post-Glover Elec. Co.
Cincinnati, Ohio.

PAUL BOWRON,
Assistant Superintendent,
Annealing Department,
Fairfield Tin Works,
Tennessee Coal, Iron & R. R. Co.,
Birmingham, Alabama.

G. A. BOWDEN,
Chief Electrician,
Fairfield Sheet & Jobbing Mills,
Tennessee Coal, Iron & R. R. Co.,
Fairfield, Alabama.

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Vandergrift, Penna.

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Askania Regulator Co.
Cleveland, Ohio.

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General Alloys Company,
Boston, Mass.

LEROY KELLS,
Sales Engineer,
Salem Engineering Co.
Salem, Ohio.

A. R. MILLER,
Engineer,
Union Metal Mfg. Co.
Canton, Ohio.

F. L. NOVAK,
Assistant to President,
Russell & Stoll Co., Inc.
New York, N. Y.

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Vice-President,
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Wean Engineering Co., Inc.
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Pittsburgh, Penna.

CLARENCE C. WIEDLING,
Technical Manager,
Socony-Vacuum Oil Co.
Chicago, Illinois.

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WEIRTON MEN INVENT BLAST FURNACE SEAL

▲ A recent addition to the list of inventions perfected by Weirton Steel employees is a blast furnace seal of revolutionary design. Patents for the seal have been applied for at the United States Government Patent Office in Washington. The seal was designed and perfected jointly by Harry Wright and William Ballard. Wright is employed in the engineering department, and Ballard in the mechanical department at the blast furnace.

For years, blast furnace men have sought a means to properly seal the openings located at the top of blast furnaces, through which gauge rods operate to determine the amount of content or "burden" inside the furnace. The "catch" in designing such a seal, however, rested in the necessity of letting the gauge rod slide up and down through the seal, and at the same time keeping the gas inside the furnace from slipping out along the sides of the gauge rod.

Wright and Ballard got an idea and went to work on it. They believed a series of layers of metal leaves surrounding the gauge rod, and leaving a "hole" slightly smaller than the rod which passed through the opening would do the trick. Considerable research and experimenting went on in the steel works machine shop until they found what they wanted. After the design was completed, and construction finished, the seal was found to work. When the rod passing through the seal was raised, the metal leaves in the seal were pulled slightly upward, and as the rod was pulled down, so were the leaves. Yet because the hole fringed by the inner edges of the metal leaves was slightly smaller than the rod passing through the hole, the leaves were pressed tightly against the rod at all times, thus preventing any gas from coming out of the furnace, through the seal.

(Please turn to page 88)

Harry Wright, lower left and William Ballard, both employees of Weirton Steel Company, are the inventors of a blast furnace seal of revolutionary design, a close-up ofwhich is shown in the upper left inset.

Courtesy Weirton Steel Employees Bulletin

"We spiked shutdowns on our Grinders by using . .

FUSES MADE TO PROTECT -NOT TO BLOW"

BUSS Super

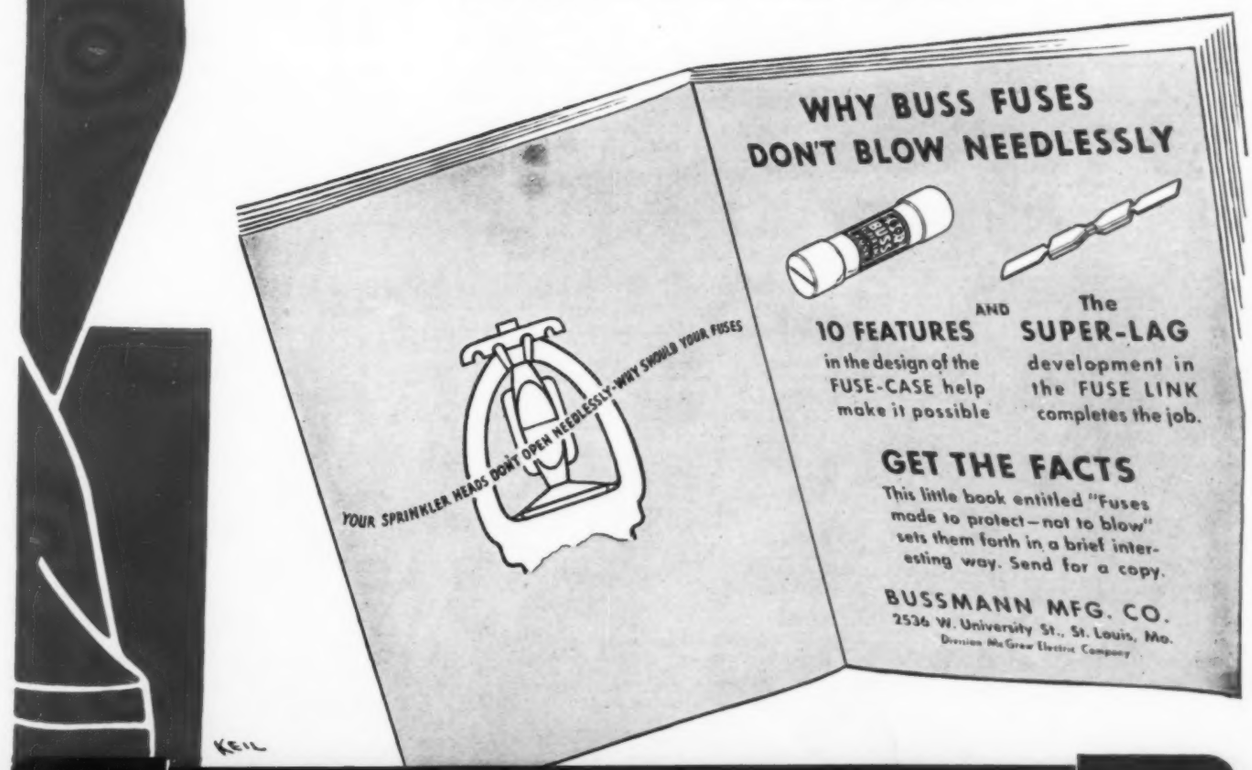
HERE'S THE STORY... Says

Mr. R. MONROE, Chief Electrician of American Brake Shoe and Foundry Co., Mahwah, N. J.

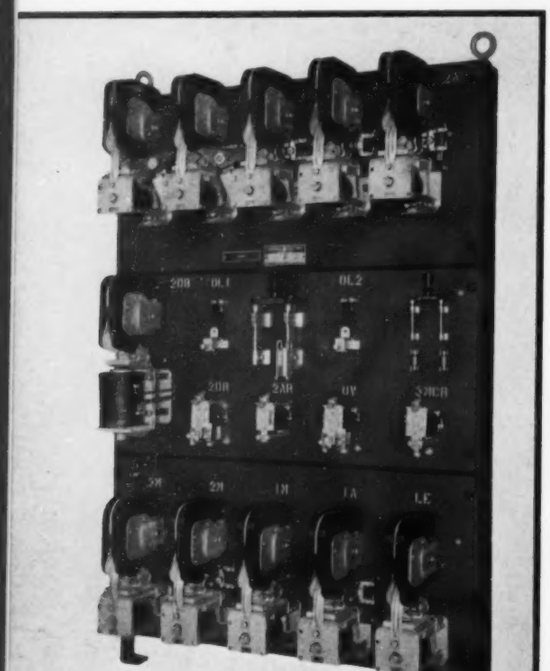
"Prior to June 29th, 1933 we experienced great trouble in getting ordinary 60 ampere 250 volt renewable fuses to hold the starting load of one of our grinders. These fuses blew about twice a week.

On June 29th, 1933 we installed BUSS Super-Lag Fuses then stood by and started the grinder up 10 times without one blow.

On January 8th, 1934 we checked this installation and found the same fuses still in service. Checked again on January 27th, 1936 and found no blows to date."


YOUR SPRINKLER HEADS DON'T OPEN NEEDLESSLY-WHY SHOULD YOUR FUSES
WHY BUSS FUSES DON'T BLOW NEEDLESSLY
10 FEATURES
AND
The SUPER-LAG
in the design of the FUSE-CASE help make it possible
development in the FUSE LINK completes the job.
GET THE FACTS
This little book entitled "Fuses made to protect—not to blow" sets them forth in a brief interesting way. Send for a copy.
BUSSMANN MFG. CO.
2536 W. University St., St. Louis, Mo.
Division McGraw Electric Company
KEIL

Lag FUSES



Direct-current crane-hoist control, equipped with tocker-bearing contactors and magnetic time relays.

DIRECT-CURRENT CRANE-HOIST CONTROL

▲ A NEW direct-current crane-hoist control, which makes use of the tocker-bearing contactors and magnetic-time relays that have proven their stamina in steel-mill service, was announced by the General Electric Company at the 1937 convention of the A. I. S. E. Among the features of the new control are high lowering speeds, excellent speed regulation, precise spotting of the hook, protection of both motor and brake from abuse, and maximum safety for the operating crew.

Power consumption is economical because regenerative braking (which returns power to the line) is obtained for any load requiring 30 per cent or greater braking effort. Dynamic braking is also available for emergency stops in case of solenoid brake failure. Automatic control of deceleration by a magnetic-time relay provides safe stopping of loads when owering. These features make possible high lowering speeds which are limited only by the inherent limitations of the motor. If desired, adjustments can easily be made to provide lower speeds.

Magnetic-time relays are employed to control acceleration in both hoisting and lowering. Accelerating and decelerating relays are independently adjustable. Accurate handling of all loads is assured by low speeds provided for both lowering and lifting.

SOUTH WORKS POWER STATION NEARS COMPLETION

▲ Carnegie-Illinois Steel Corporation will soon complete and put into operation a new power station, No. 5, at its South Works in Chicago.

This station will replace older equipment and will provide for future expansion and, to a certain extent, centralize power facilities.

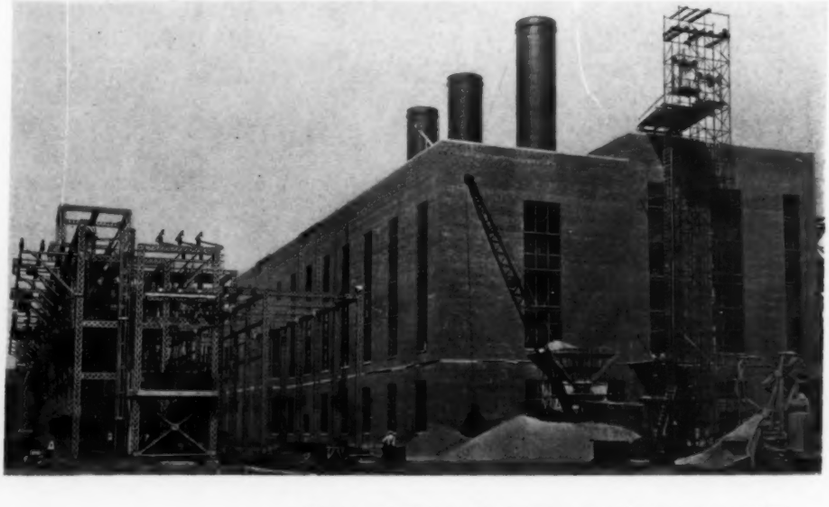
Surplus blast furnace gas will be used as primary boiler fuel with natural gas and oil as secondary fuels. Provisions have also been made to use pulverized coal for secondary fuel after the bulk of the surplus blast furnace gas has been utilized for metallurgical purposes. The yard layout and building design provides not only for storage, handling and pulverizing facilities, but also for dust collectors to prevent the discharge of flyash from the stacks.

The building has a maximum length of 275 feet, a width of 124 feet 5 inches, a height of 88 feet, and covers an area of 30,000 square feet. It will house three boilers, each with a capacity of 300,000 pounds of steam per hour, one 25,000 kw. condensing turbo-generator operating at 1,500 r.p.m. and three 75,000 c.f.m. condensing turbo-blowers, operating at 3,000 r.p.m. against a maximum discharge pressure of 30 pounds per square inch gage. Space is also provided in the present building for one additional boiler and for a 50,000 kw. turbo-generator.

Steam will be supplied to the turbine throttles at a pressure of 450 pounds per square inch and a temperature of 750° F. The boilers which will supply this steam are of the four-drum bent tube type, each having 22,000 square feet of heating surface and a 17,150 cubic foot furnace with an additional heating surface of 6,200 square feet in the water-cooled walls and slag screen. Each boiler is equipped with a 7,180 square foot economizer and a 6,450 square foot superheater.

Gases leaving each economizer divide and pass through two 26,200 square foot regenerative type air heaters, where they give up waste heat to the combustion air. After leaving the air heaters these gases are discharged by induced draft to a 14-foot diameter concrete-lined steel stack supported on the building steelwork. Each of the two induced draft

New power station No. 5, South Works, Carnegie-Illinois Steel Corporation, is rapidly nearing completion. This will centralize power facilities and replace older equipment.



fans serving each boiler has a maximum capacity of 192,000 c.f.m. of gas. One is driven by a geared turbine and the other by a two-speed motor.

Each boiler has two forced draft fans, one motor driven and the other turbine driven, each designed to deliver 45,000 c.f.m. of air through the air preheaters to the burners. Furnaces are fired tangentially and each boiler will be operated by complete automatic combustion control.

Makeup, for replacing the water and steam losses from the system, is expected to run about 20 per cent of the total feed-water supply. The makeup water will be taken from the lake and treated by a hot process lime and soda ash softener. Feed water will be pumped to the boilers by three centrifugal 3500 r.p.m. boiler-feed pumps with a capacity of 750 g.p.m. each at a head of 1.427 feet, two being motor driven and one turbine driven. The feed-water heating cycle will include a 600,000 pound per hour de-aerating heater and two closed heaters using steam extracted from the turbine at pressures of 80 and 40 pounds per square inch absolute.

Electrical control equipment will be located in a separate, two-story building, 67 feet long and 32 feet wide, which also provides offices for the load and fuel dispatchers and the power production department. Power from Nos. 1 and 5 power stations will be stepped up, and power over the corporation's 66 KV lines from the Gary and Buffington plants will be stepped down for distribution through the plant in a central outdoor substation.

Water for the condensers and boilers will be taken from Lake Michigan through an intake provided with traveling screens, each having a capacity of approximately 50,000,000 gallons per day, sufficient to meet the needs of a city of about 1,000,000 population. The water will flow by gravity to the station through a 10-foot by 10-foot concrete tunnel 1,400 feet long.

At the station it will be pumped through the condensers by vertical motor-driven pumps. The turbo-generator condenser has a cooling surface of 20,000 square feet and each of the turbo-blower condensers, 3,850 square feet. The condensate will be removed by duplicate, motor-driven pumps to be used again for feed water to the boilers. Non-condensable gases which would in time build up and destroy the vacuum will be removed from each condenser by twin steam jet air pumps.

Although most of the steam from the boilers is used by these turbines, some of it will be used in single-stage evaporators which will supply 150 pound steam to the plant for miscellaneous uses.

General view of the new motor aisle, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

WESTINGHOUSE OPENS NEW MOTOR AISLE

▲ "THE best handling of any product is generally conceded to be the least handling of it, since the customer and the manufacturer both benefit from the resulting high quality, prompt delivery and low cost", declared Superintendent G. S. Ryan in explaining the fundamental planning behind Westinghouse's new mass production industrial a-c motor aisle.

"If you consider as we do, that such items as castings, magnetic sheet steel, axle steel, insulated wire, cotton tape, paints and varnishes are raw materials, then we have consolidated in one location at East Pittsburgh, virtually all of the work required to build, warehouse, and ship industrial induction motors", he continued. "We feel that the best results can be obtained by bringing together in the proper relationship in one area, on one floor level and under one responsibility, all operations for building a-c motors.

"To provide the required space, an open court between two buildings was roofed over with a welded structure and the separating walls removed. The area thus provided 197,000 sq. ft. which was floored with reinforced service facilities such as electric power, compressed air, ventilation, heat distribution systems, fire protection devices and lavatories were installed.

"The essential parts of a standard induction motor are a frame, a stator core, a set of stator coils, an axle or shaft, a rotor core with winding, a set of bearings and two brackets to house the bearings and support the rotating element. While the design of many of these parts has been standardized making possible their production in large quantities, there is a growing demand for custom built jobs for particular applications.

"To obtain the benefits of quantity production without interference from the special items two manufacturing lines have been set up. One consists largely of special purpose equipment designed for the production of standard parts and motors, and the other of general purpose equipment for the production of special items and custom built motors.

"Each of these lines has unit manufacturing centers that supply parts by conveyor to sub-assembly and final assembly positions. In each line the objective has been to so arrange the departments that the flow of work will be from the raw material storage at one end of the building to the finished motor storage and Shipping Department at the other end. The principal items of raw material such as magnetic sheet steel, axle steel and castings are delivered in broad gauge railroad cars to the allotted storage areas adjacent to the machining departments.

"The design and location of each machine tool, bench and conveyor

has been studied by the layout engineer, tool supervisor, time study men, production scheduling department, the foreman of the department, and the general foreman.

"In many instances the design engineers have suggested changes in the product which greatly influenced the factory layout. Each operation has been analyzed in detail with a view to keeping the machinery and workman gainfully employed. To do this requires that the movement of pieces between operations be kept as nearly as practical at the proper working height.

"Gravity roll conveyor has been used most to accomplish this result. Some use has been made of power driven booster belts and live roll conveyor while overhead chain conveyor is used in the processing of stator windings. Caster type boxes have been introduced to handle small finished parts from machining through storage to assembly. It has been our aim to limit the use of cab operated cranes to the handling of large weights and they are found principally in the raw materials and finished motor storage areas.

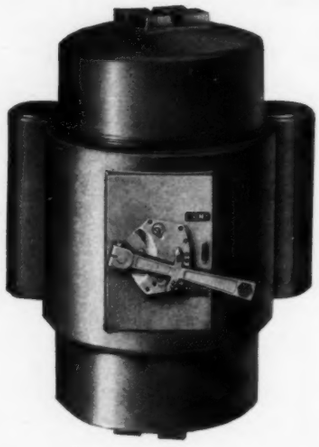
"Each improvement made in the rearrangement suggests so many others that the educational value of the project alone justifies the expenditure", concluded Mr. Ryan.

NEW TYPE HOUSING FOR CONTROL DEVICES

▲ The Crouse-Hinds Company, Syracuse, N. Y., announces a new development known as type EPC condulets which are designed as explosion-proof and dust-tight housings for various circuit breakers, control devices, or combinations of such devices.

The condulet consists of a body into which are threaded two cylindrical tubs. The ends of these tubs are provided with grooves into which a bar may be placed to tighten or loosen the tubs. The tubs have tapered threads which make the joint explosion-proof, dust-tight, and weatherproof, and are treated to facilitate removal.

The condulet body is provided with four conduit hubs: two at the top and two at the bottom. These hubs have tapered threads and integral bushings. This hub arrangement makes it possible for conduit to enter or leave from either direction. Two of the condulet hubs are provided with removable threaded plugs.



Type ECP Condulets, designed as explosion-proof and dust-tight housings for various circuit breakers and control devices.

Three substantial mounting lugs are provided: Two at the bottom with open slots and one at the top with a keyhole. This arrangement saves time in mounting, as the condulet may be supported by the top bolt while the lower bolts are being located and tightened.

The devices are mounted on supporting members attached to the body and are enclosed by the tubs. When the tubs are removed, the devices are easily accessible for wiring, inspection or replacement. The external operating means are located in or on the front of the body.

This type of housing is adaptable to a variety of uses, some of which are as follows:

Quick Action Switches.

Circuit Breakers, dry mounted or oil immersed.

Magnetic Remote Control Motor Starting Switches, dry mounted or oil immersed.

Circuit Breaker and Contactor Combinations.

Circuit Breaker and Magnetic Remote Control Motor.

Starting Switch Combinations. Combinations may be dry mounted, oil immersed, or with one device dry and one oil immersed.

Other devices and combinations can be arranged for when required.

ROPE GUIDE HOIST

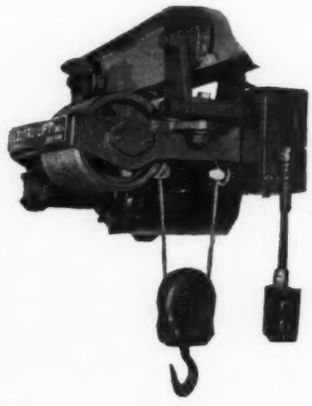
▲ The new rope guide hoist, built by Electro Lift, Inc., No. 30 Church Street, New York City, has been designed especially for side and end pulling or wherever the loads cannot be brought directly under the hoist.

This hoist has a drum with deep grooving allowing the cable to be completely submerged within the grooves. It is fitted with a traveling guide having a finger which runs in the groove ahead of the cable and which holds the cable in its proper groove.

The electro lift rope guide hoist eliminates the hazard of crossed or piled up cables thus increasing the cable life and reducing cable breakage particularly where loads are pulled at an angle to the vertical.

This hoist is built in sizes of ¼ to 5-tons, and has all the speeds and ratings of standard electro lift hoists. It has worm drive with worm and wheel running on Timken tapered roller bearings, fully enclosed within the gear case and running in a bath of oil. This provides simple construction and quiet operation. The motor has ball bearings and is directly attached to the hoist frame giving compact arrangement. The entire load is carried on a rigid cast steel frame. The hoist has close head-room allowing the hook to reach within a minimum distance of the overhead track. It has a safety type hook block with a guard which completely encloses the bottom sheave.

Rope guide hoist especially designed for side and end pulling.



The E. W. Bliss Company is now building 16—4 Hi Temper Pass Mills, size 18″ and 42½″ x 42″. Also 3—2 Hi Temper Pass Mills, size 32″ x 84″. The 16—4 Hi mills are being equipped with 4 Row Tapered Bearings 18″ x 30″ x 20¾″ long. The 3—2 Hi mills are being equipped with 4 row Tapered Bearings each 19¼″ x 26″ x 14⅜″ long.

Based on experience in many mills over a period of time, Bliss can look to the performance of these mills with confidence because *all the Backing Roll Bearings are Bantam Tapered Roller.*

Follow the example of leading mill builders—specify Bantam.

BANTAM BEARINGS CORPORATION
SOUTH BEND, INDIANA
SUBSIDIARY OF THE TORRINGTON CO.
TORRINGTON, CONN.

TAPERED ROLLER
STRAIGHT ROLLER
BALL BEARINGS

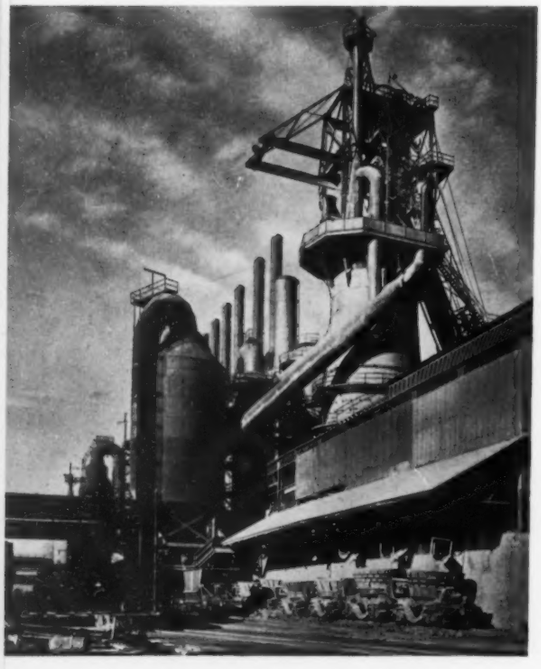
BANTAM
BEARINGS

It is built in both single and twin hook types, the latter for handling long loads. The control may be either rope type or push button type, the latter giving accurate control of the load by jogging. Top and bottom limit switches may also be provided to stop the load in each direction of travel, preventing running the cable off the drum and providing an accurate stop at the bottom as well as at the top.

NEW REPUBLIC BLAST FURNACE COMPLETED

▲ The new 1000-ton blast furnace has recently been completed at the Corrigan-McKinney plant of Republic Steel Corp. in Cleveland, adjacent to the open hearth furnaces which will supply steel to Republic's new 98-inch continuous strip mill, largest in the world, when it enters regular production. Molten iron from this modern furnace, which replaces a 600-ton furnace built 20 years ago, will be cast into pig iron or transferred to the open hearth plant where it will be transformed into steel destined for the continuous mill.

New 1000-ton blast furnace recently completed at the Corrigan-McKinney plant of Republic Steel Corp. It is located adjacent to the open hearth furnaces which will supply steel to Republic's new 98" continuous strip mill.



Dome type ventilated reflector designed to eliminate much direct glare.

DOME TYPE VENTILATED REFLECTOR

▲ The newly developed Benjamin dome combination unit, a development of the Benjamin Electric Company, utilizes an arrangement of three 150-200 watt lamps around a central mercury lamp of 400 watts to produce a light which is both visually comfortable and which possesses the property of blending well with daylight.

Lighting of this type has been studied and found to be psychologically favorable to workers and conserving of physical energy through the reduction of eye and nerve strain.

The 120 degree spacing of the three incandescent lamps around the central mercury lamp, assures well blended light in all directions so that overlapping illumination in general lighting systems will maintain a more uniform color over the entire area. The mixing of these two distinctly different types of lamps produces a blend of light which permits a fair degree of color discrimination.

The Benjamin Dome type, ventilated reflector of porcelain enameled steel provides a wide, even distribution of light on both horizontal and vertical surfaces. An opal glass cylinder surrounds the lower portion of the mercury lamp. This lowers the normal 78 degree cut off of the reflector to 61 degrees which greatly minimizes the possibility of direct glare.

In the event of momentary current failure the incandescent lamps supply stand by illumination during the short interval necessary for the mercury to cool and automatically restart.

NEW BULLETINS AND BOOKLETS

▲ RECENT developments in higher steam pressures and temperatures, in boiler and combustion equipment, in steam turbines and in the application of exhaust and bled steam, and how these have all combined to make possible great economies in the generation of power and heat for buildings and industrial plants, is the theme of a 12-page, 11 x 16 in. brochure entitled "Modern Turbines to Reduce Costs", issued by the De Laval Steam Turbine Co., Trenton, N. J. Cheaper fuels can now be burned with less labor and with higher efficiency and much more power can be generated from a given weight of steam than formerly. Less building space is required, or increased demands for power can be met without increased costs for buildings and foundations. In many cases existing equipment, if in good condition, can be retained by superposing a high pressure boiler and turbine, the latter exhausting into the present steam mains. Engineers and owners of steam plants may study with interest and profit the great variety of steam turbine applications which are set forth in the text and illustrations of this publication, which will be sent free upon request.

▲ THE Ohio Electric Mfg. Co. of Cleveland has issued Bulletin No. 110 describing its improved lifting magnets and magnet controllers. These controllers cause the magnet to drop its load so promptly as to make possible operating speeds up to ten lifts per minute. Copies are available by addressing the manufacturer.

▲ SURFACE Construction Corporation, Toledo, Ohio, has just issued a new forty-page booklet entitled "Heating and Heat Treatment of Metals".

This booklet traces the subsequent applications of heat from the ingot soaking pit to the last phases in which heat is applied to the metal. In brief, this booklet traces the heredity of metals, and of steel in particular, through heating and heat treating. It is available to anyone interested in the subject.

ITEMS OF INTEREST

Thomas J. Bray, Jr., was appointed assistant to vice president and general manager of sales for the Carnegie-Illinois Steel Corporation, Carnegie Building, Pittsburgh, Pennsylvania. Mr. Bray, after leaving Lehigh University, was first employed by the Republic Iron and Steel Company, more recently by the Koppers Company, and has been with the Carnegie-Illinois Steel Corporation for the past two years. He will take over the special duties heretofore performed by Mr. Louis C. Lustenberger, now retired, and will also continue as assistant manager of sales of the bar, strip and semi-finished materials division of the general sales department in Pittsburgh.

▲

Louis C. Lustenberger has recently retired from service for the Carnegie-Illinois Steel Corporation. Mr. Lustenberger had been employed by the Carnegie-Illinois Steel Corporation and its predecessors for thirty-five years. He served in various capacities, being assigned mostly to special sales responsibilities, building up a remarkable relationship with his trade. Although Mr. Lustenberger's retirement was in accordance with the United States Steel Corporation's established plan, he continues to display a very active interest in the steel business today.

▲

George H. Ritchie, chief engineer of the transportation department of the Tennessee Coal, Iron & Railroad Co., Birmingham, Ala., has been promoted to general superintendent of that department, according to Thomas Chalmers, vice president in charge of operation. Mr. Ritchie succeeds Henry J. Wurtele, who has become vice president of the Birmingham Southern Railroad Co., succeeding W. H. Smith who resigned last August.

Mr. Ritchie joined the Tennessee Coal, Iron & Railroad Co., as a draftsman in 1910, leaving the service of the company for a year and returning in 1912 as assistant chief engineer of Birmingham Southern railroad and TCI transportation department. He became chief engineer of that department in 1930.

▲

Dr. E. H. Leslie, authority on the chemical process industries, has joined the technical staff of the Blaw-Knox Company, Pittsburgh, Pa. In his new capacity, Dr. Leslie will be charged with the supervision of the design and fabrication of operating units for the chemical and oil refining industries.

Dr. Leslie is best known to the industrial world for his work as consulting engineer and for his operation, since 1923, of the Leslie Laboratories at Ann Arbor, Michigan. Through his researches, he has been prominently influential in the application of advanced chemical engineering to the problems of the chemical, petroleum refining, and processing industries generally.

Dr. Leslie received his bachelor's degree at the University of Illinois, with the class of '13, and the degree of Doctor of Philosophy at Columbia in 1916. For eight years, he was professor of chemical engineering at the University of Michigan.

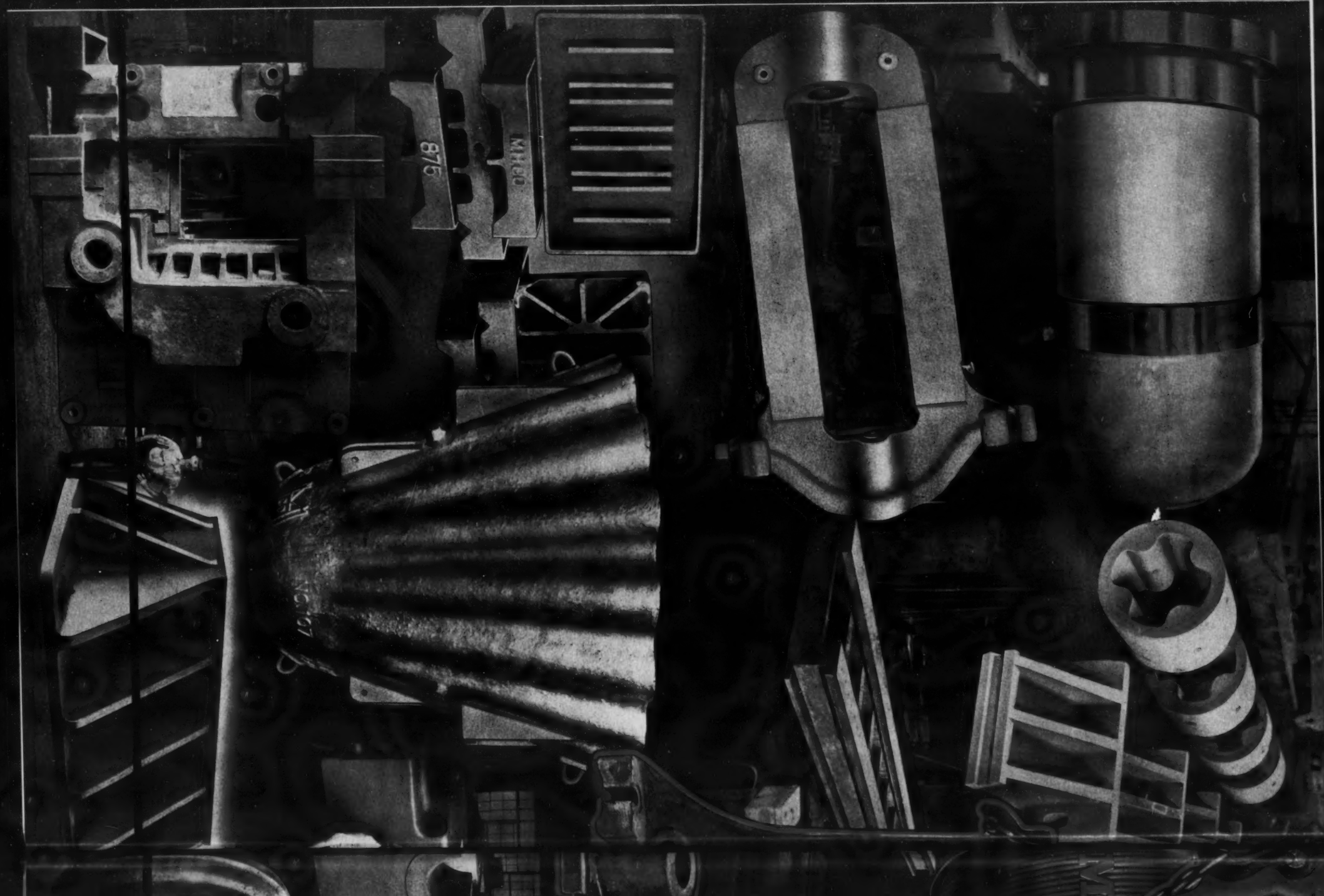
▲

(Please turn to page 96)

THOMAS J. BRAY, JR.

DR. E. H. LESLIE

MACKINTOSH-HEMPHILL COMPANY, PITTSBURGH AND MIDLAND, PA.



1,000
TO
90,000 LBS.

MACKINTOSH STEEL CASTINGS

ACID
OPEN-HEARTH
PRACTICE

CLEAN
AND TRUE
TO PATTERN

MEETING CHEMICAL
AND PHYSICAL
REQUIREMENTS

One of Mackintosh-Hemphill's plants is devoted exclusively to steel castings. It has the most modern equipment, with chemical and metallurgical laboratories that enable it to meet any specifications.

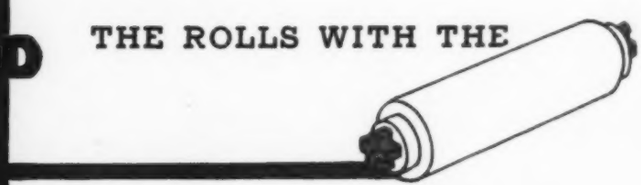
We would welcome an opportunity of discussing your heavy and medium-size steel castings with you.

ALSO

IRON CASTINGS — **MACHEMPITE CASTINGS**

IRALITE CASTINGS — **ADAMITE CASTINGS**

AND THE ROLLS WITH THE RED WABBLERS



T. M. Robie has been appointed as manager of the diesel sales division of Fairbanks, Morse & Co., Chicago, it was announced by A. C. Dodge, vice president in charge of sales. Mr. Robie has been associated with Fairbanks-Morse since he returned from World war overseas service in 1919, serving in numerous capacities in the manufacturing and sales division. Since 1932 he had been in charge of Diesel sales to resale manufacturers. Previously, he was associated with the New York branch office for one year and the Dallas office for two years, and was employed at the factory on Diesel engine designing, testing and building for nine years. Upon graduation from the University of Michigan in 1914, where he specialized in the study of internal combustion engines, Mr. Robie was employed by General Electric Co. He operated Diesel power plants in New Mexico for two years previous to entering war service.

▲

F. J. Elliott has been named Cleveland District Sales Manager, for the Rustless Iron & Steel Corporation, Baltimore, Maryland, with offices at 731 Society for Savings Building, 145 Public Square, Cleveland, Ohio.

Mr. Elliott, who will handle sales and service in the State of Ohio, was formerly with E. F. Houghton & Company.

▲

Died

Timothy Burns, who retired as general manager of the Lackawanna works, at Buffalo, of the Bethlehem Steel Corp. in the fall of 1936, died at Bethlehem, Pa., December 11. For many years Mr. Burns had been associated with the Bethlehem company, first at the Maryland plant at Sparrows Point, Md., then as superintendent of the Saucon plant at South Bethlehem, Pa., and later for 12 years as general manager of the Lackawanna plant. Stricken by a heart attack in the spring of 1936, Mr. Burns was relieved from active duties and spent last winter in Nassau, B. I. However, he continued with Bethlehem in an advisory and consulting capacity. He was active in civic affairs of Buffalo and at one time was a director of the Buffalo club.

▲

Eugene J. Buffington, former President of the Illinois Steel Company, died recently in Chicago. He was 74 years old.

Mr. Buffington served for 34 years as president of the Illinois Steel Company, now a part of Carnegie-Illinois Steel Corporation. A graduate of Vanderbilt university, Nashville, Tennessee, of which for many years he has been a trustee, he became identified with the iron and steel industry in 1884 as director and treasurer of the American Wire Nail Company, Covington, Kentucky.

This company later constructed a wire and nail plant at Anderson, Indiana, and when the American Steel & Wire Company of Illinois acquired this plant in 1898, Mr. Buffington continued as director, member of the executive committee and treasurer. In January, 1899, he succeeded John W. Gates as president of the Illinois Company.

▲

Ernest J. Poole, 64, of Reading, Pa., vice president in charge of production of the Carpenter Steel Co. since 1928, died in Harrisburg, Pa., Nov. 16, while attending a conference of the State chamber of commerce, of which he was president. Born in Butler county, N. J., Mr. Poole was educated in the public schools. He joined the Spauling & Jennings Steel Co., Jersey City, in 1890, and in 1904 became a salesman for the Carpenter Steel Co., of Reading. Since 1928 he had been vice president in charge of production.

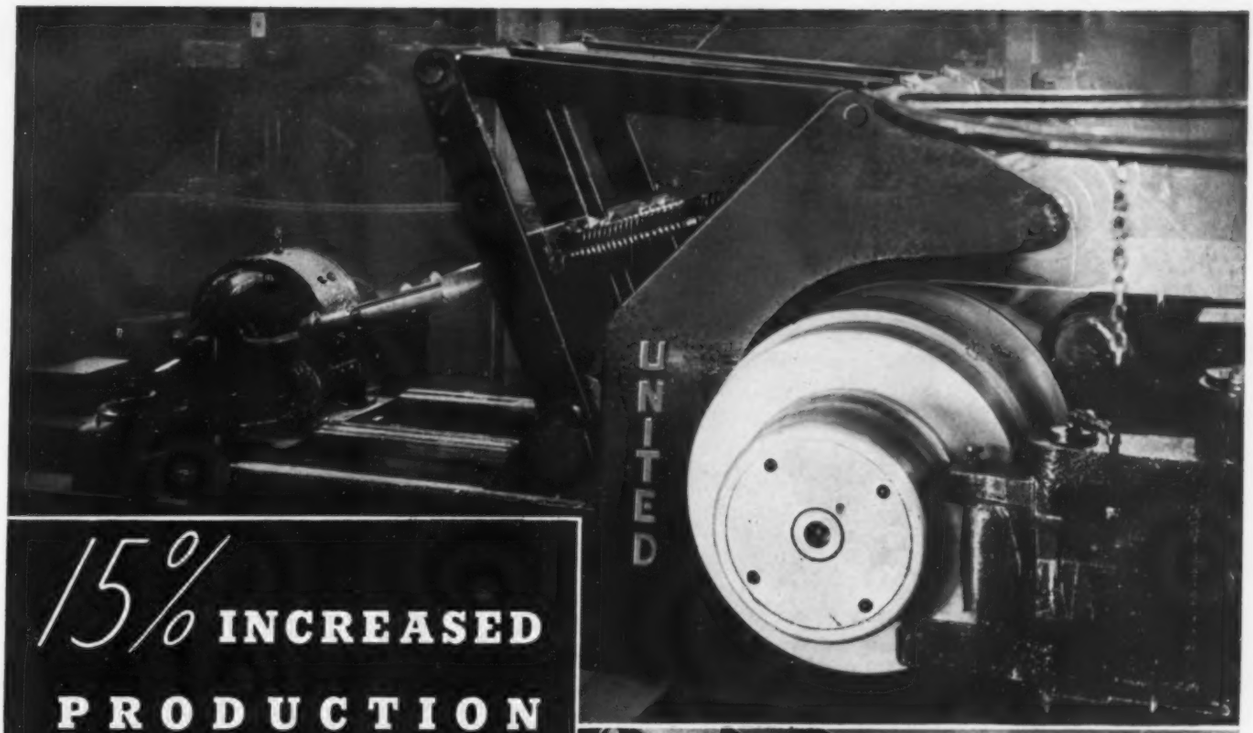
▲

Charles H. Champlain, retired general works manager of the main plant of Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., died December 2 in Pittsburgh. Mr. Champlain retired in 1934, after being with the Westinghouse company for 36 years. His various connections in Westinghouse had included general foreman in charge of the manufacture of all railway transportation rotating equipment for Westinghouse, general foreman in the manufacture of industrial generators, assistant works manager at East Pittsburgh, works manager at Sharon, Pa., and general works manager at East Pittsburgh.

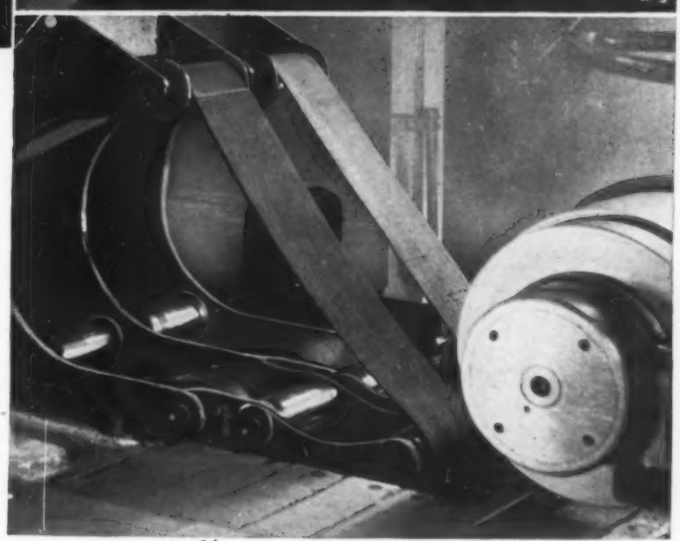
▲

Willis McKee, 64, iron and steel works engineer in Cleveland for nearly 20 years and a brother of Arthur G. McKee, president of Arthur G. McKee & Co., died in Cleveland, December 4, after a short illness. Born in State College, Pa., Mr. McKee went to Cleveland in 1918 and worked as an independent engineer and operator. He was general manager of the Elyria Iron & Steel Co., now merged with Steel & Tubes, Inc., from 1904 to 1918. Mr. McKee was the inventor of many improvements in the manufacturing of steel.

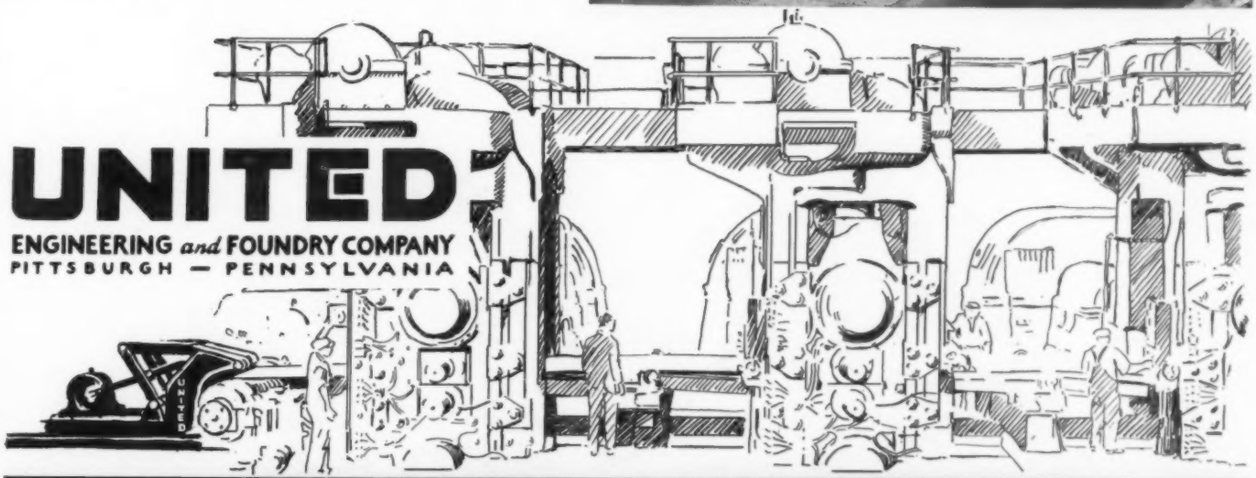
The Association has on hand at the national office, 1010 Empire Building, Pittsburgh, Penna., a supply of the new Association pins. Every member should have one of these attractive insignias. The cost is $1.00.



15% INCREASED PRODUCTION



● United Belt Wrappers are now successfully wrapping cold reduced strip on collapsible tension reels up to 48" wide and up to No. 18 gage (.050" thick) in regular production.



UNITED
ENGINEERING *and* FOUNDRY COMPANY
PITTSBURGH — PENNSYLVANIA

ASSOCIATED COMPANIES: DAVY AND UNITED ENGINEERING COMPANY, LTD., SHEFFIELD, ENGLAND DOMINION ENGINEERING WORKS, LTD., MONTREAL, P. Q.

Significant ?

REHABILITATION AND MODERNIZATION

IN THE IRON AND STEEL INDUSTRY DURING 1935

▲ OF THE ESTIMATED $150,000,000 expended in the industry for new steel producing equipment during ... fully 85% of this amount was allocated ... finishing departments. Of out- ... this period were the 31 hot ... ed, under

ROLLING MILLS

Blooming and Slabbing Mills

One new blooming mill was purchased, one existing mill was revamped, and an order was placed with a mill builder for a slabbing mill.

All of the above units are being designed ostensibly to supply semi-finished steel to flat rolling units. ... Laughlin Steel Corporation is, at ... reversing blooming ... ech for fur-

HOT STRIP MILLS AND CAPACITIES COMPLETED DURING 1935

Company	Location	Size	Annual Capacity
Carnegie-Illinois Steel Corp.	Gary, Ind.	38" (revamped)	300,000
Carnegie-Illinois Steel Corp.	McDonald, O.	42"	360,000
Youngstown Sheet & Tube Co.	Youngstown, O.	79"	600,000
Bethlehem Steel Company	Lackawanna, N. Y.	79"	600,000
Ford Motor Company	Detroit, Mich.	54"	480,000

In every one of these modernizations, were included "Tool Steel" gears - crane wheels - rolls (leveller - coiler - pinch) or other products.

Steel mills and their equipment builders can certainly be expected to know steel quality. They select one type of material — after years of test

SEASON'S GREETINGS

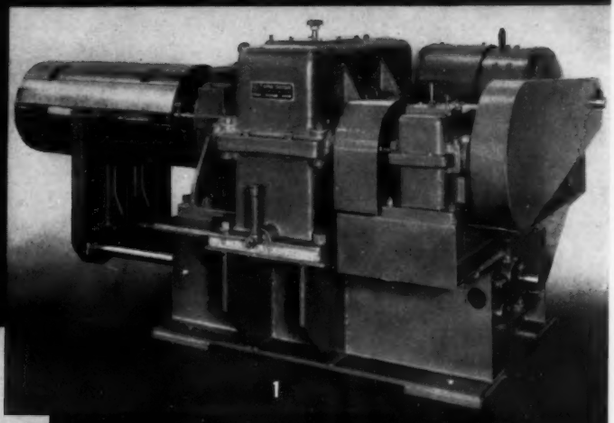
We at our Plants in Plainville,
Ludlow, Trenton, San Francisco, Seattle
and Los Angeles, and our entire sales organization
wish you all a Merry Christmas and a Happy New Year

The TRUMBULL ELECTRIC MFG. CO.

PLAINVILLE — A GENERAL ELECTRIC ORGANIZATION — CONNECTICUT

NEW YORK • CHICAGO • BOSTON • DETROIT • ATLANTA • PHILADELPHIA • LUDLOW • NASHVILLE • SAN FRANCISCO • LOS ANGELES • SEATTLE

Coilers

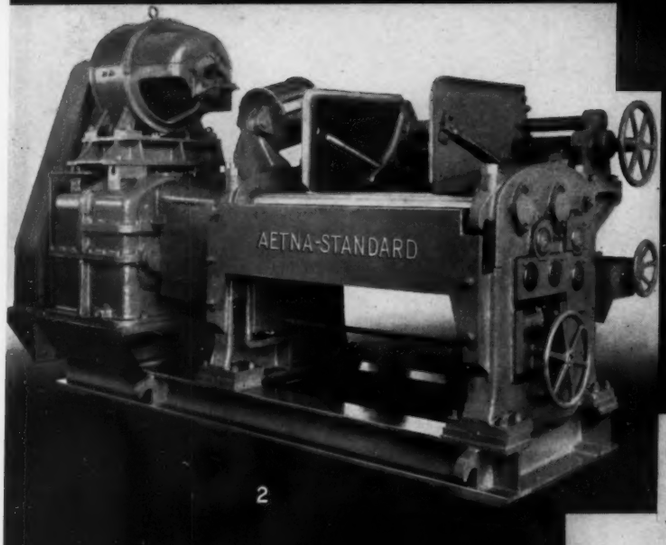


1

1 . . . TITE COILER

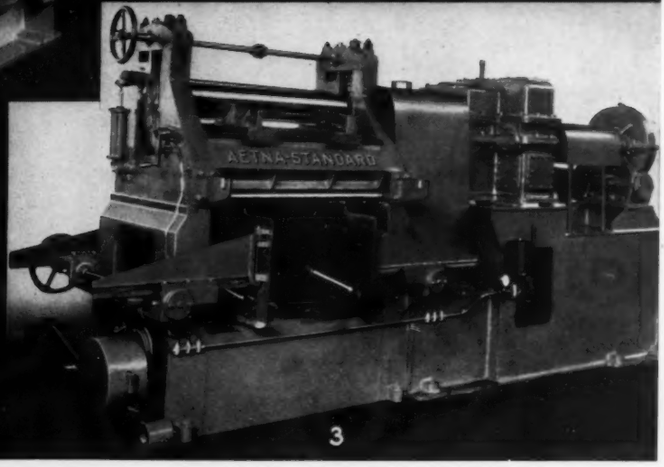
2 . . . UP COILER

3 . . . DOWN COILER



2

Consult Aetna-Standard on complete strip handling equipment for all finishing operations . . . .



3

THE AETNA-STANDARD ENGINEERING COMPANY

CONSULTANTS · DESIGNERS · BUILDERS

STEEL AND NONFERROUS INDUSTRIES

YOUNGSTOWN « OHIO » U. S. A.

EXCLUSIVE ADVANTAGES
of
SCHLOEMANN 'MOTOR-ROLLERS'

With the rotating trunnion-type roller housing the driving motor, the necessity for using line shafts, couplings and gear reduction units is eliminated. Simplified table construction is the result, affording free access along both sides of "Motor-Roller" Tables.

Installation of rollers between the housings of mill Stands and Shear Housings is possible without introducing complicated or weak elements.

Fewer wearing parts provide the ruggedness and dependability essential in mill service with reduced operating and maintenance costs.

Each "Motor-Roller" installation is designed and built for the particular requirements of its application.

SCHLOEMANN
ENGINEERING CO. PITTSBURGH, PA.
Rolling Mill Machinery Hydraulic Presses

NEW COKE OVENS IN DETROIT

MANY MILLS INSTALL NEW MACHINERY

STEEL PRODUCTION INCREASES

Output Above Figure of Year Ago

NEW HIGHS PREDICTED

Operations Increase Steadily Pace

BUSINESS WITHOUT BREAKDOWNS

G AND K FOUNDRY ADDS NEW EQUIPMENT

Will Take Care of Present and Predicted Demand

WITH DELTABESTON ASBESTOS-INSULATED WIRE AND CABLE

In hundreds of plants and factories, men are accepting the challenge of increasing demand. They are answering it with new machines, improved equipment and dependable power. Because dependable power means reliable wire and cable — they are specifying Deltabeston Conductors.

Deltabeston Wire and Cable is insulated with asbestos. But that's just half the story. It is *purified, felted* asbestos. Foreign particles, detrimental to insulation resistance are removed. The insulation is felted to the conductors to eliminate cracks, joints and seams.

Purified, felted Asbestos makes Deltabeston different . . . makes it the wire and cable to use where heat and moisture, grease and oil would ruin ordinary insulation. In the interests of eliminating needless interruptions in power supply, reducing motor failure, equip your plant with Deltabeston Power Cable and Motor Lead Cable and specify Deltabeston Magnet Wire for all types of motor windings.

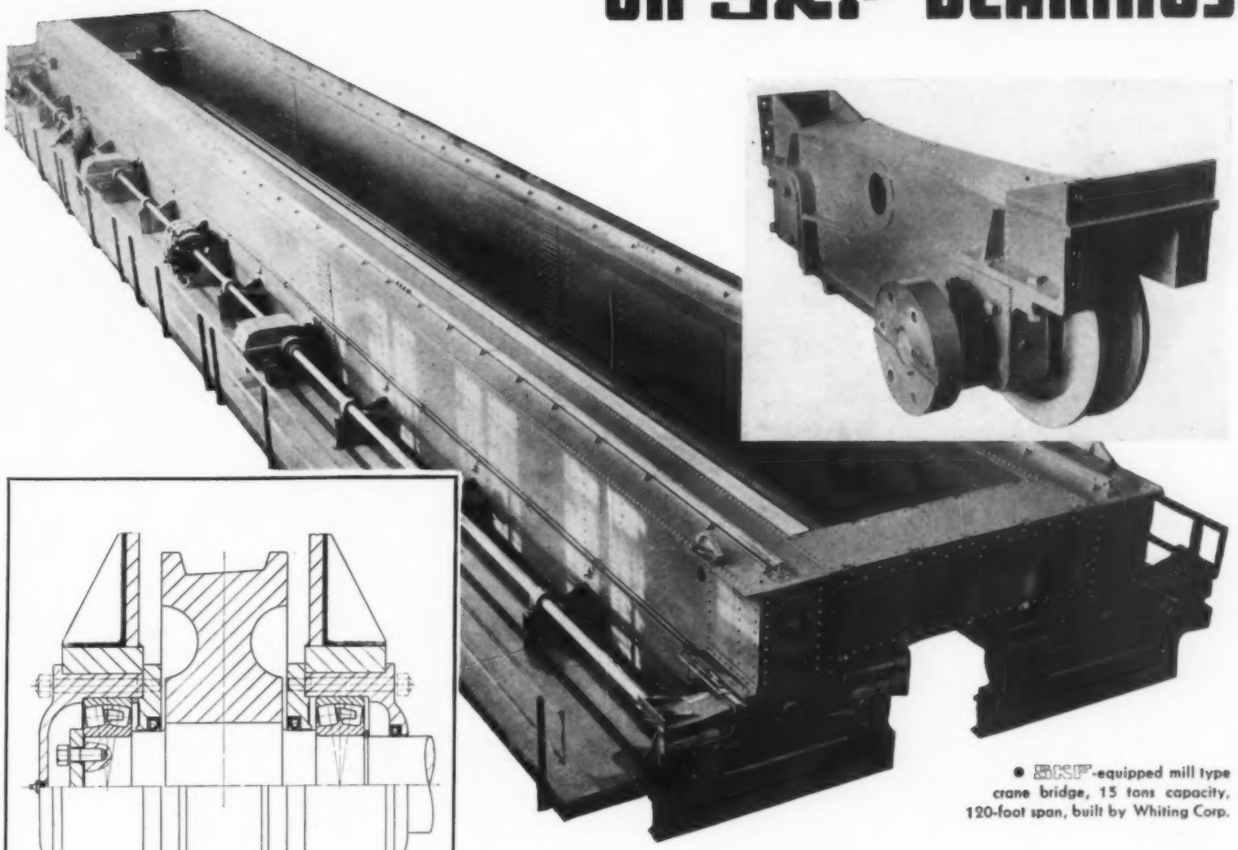
Deltabeston Wire and Cable is distributed by General Electric Merchandise Distributors and Graybar Electric Company. For complete information write to Section Y-612, Appliance and Merchandise Department, General Electric Company, Bridgeport, Connecticut.

GENERAL ELECTRIC

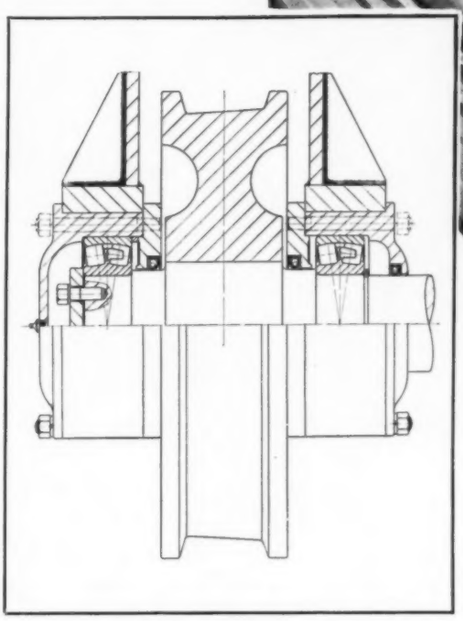
DELTABESTON WIRE AND CABLE

APPLIANCE AND MERCHANDISE DEPARTMENT, GENERAL ELECTRIC COMPANY, BRIDGEPORT, CONNECTICUT

CRANES EARN PROFITS ON SKF BEARINGS



● SKF-equipped mill type crane bridge, 15 tons capacity, 120-foot span, built by Whiting Corp.



● The ability of SKF Bearings to align themselves enables them to give profit-paying performance on this Whiting bridge track wheel—long axle.

No matter whether the truck is unloaded or carrying the full working load, SKF Bearings compensate for any deflection that may occur.

One bearing is held laterally while the other is free endwise—and both are easy to assemble and disassemble. Result: high load carrying capacity . . . long life . . . low operating costs. If you want the right bearing in the right place, specify SKF.

SKF INDUSTRIES, INC.
FRONT STREET & ERIE AVENUE, PHILA., PA.
3953

SKF ROLLER BEARINGS

11 PULP AND PAPER MILLS SELECTED

STURTEVANT *Mechanical Draft Fans*

for

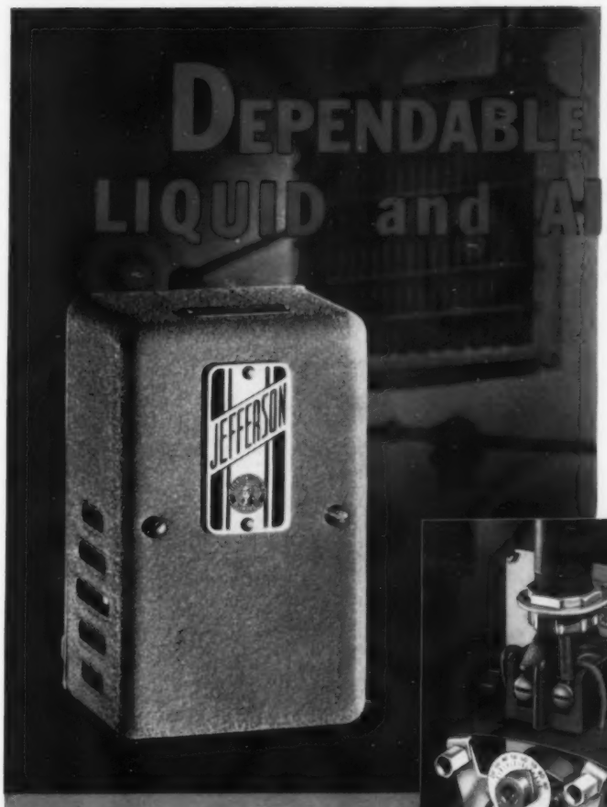
recent installations

1. Crossett Lumber Co. . . . . Crossett, Ark.
2. Brunswick Pulp & Paper Co. . Brunswick, Ga.
3. Southern Kraft Corp. . . . Georgetown, S.C.
4. Southern Kraft Corp. . . . Spring Hill, Ark.
5. Chesapeake Camp Corp. . . . Franklin, Va.
6. Kieckhefer Container Corp. . Plymouth, S.C.
7. W. V. Pulp & Paper Co. . . Charleston, S.C.
8. Champion Paper & Fibre Co. . Houston, Texas
9. National Container Corp. . Jacksonville, Fla.
10. Gaylord Container Corp. . . Bogaloosa, La.
11. Mead Corporation . . . Kingsport, Tennessee

B. F. STURTEVANT CO., Hyde Park, BOSTON, MASS.
Branch Offices in 40 Other Cities
B. F. Sturtevant Company of Canada, Limited—Galt, Toronto, Montreal

Sturtevant
REG. U. S. PAT. OFF.
Puts Air to Work

DRAFT FANS · TURBINES · GEARS · ECONOMIZERS · AIR HEATERS



Above: Tamper-proof type Air Switch.

Right: Same with case removed, showing range plate and slot for adjustment of temperature range; bi-metallic element, and at top, the solid bakelite terminal block.

CONTROLS FOR . . . R TEMPERATURES

● Jefferson Temperature Controls eliminate manual control, reduce delays, save fuel costs, maintain uniform temperatures, increase efficiency — and provide dependable control at low cost.

Simple and sturdy they employ non-breakable Ferro-Tube Mercury Contacts actuated by a bi-metallic temperature sensitive element. Conveniently arranged for easy installation with clearly marked range adjustments, they are sensitive, accurate and dependable.

Types are available for — (1) Immersion control — with the temperature sensitive helix protruding into a well or tube for controlling liquid temperatures, — (2) Surface Control — with the bi-metallic element in contact with the wall or surface to be controlled, and (3) Air Switches or Industrial Thermostats for the control of room or duct temperatures.

All essential data are contained in Bulletin 371-TC, a copy of which will be mailed on request. JEFFERSON ELECTRIC COMPANY, Bellwood (Suburb of Chicago), Illinois.

Jefferson Immersion Type Control with exterior range plate and adjustment knob.

A TAMPER-PROOF AIR SWITCH CONTROL

For the many cases where the unauthorized adjustment of temperature ranges is not desired—Jefferson has added an Air Switch Control that has no exterior range scale plate or adjustment knob, thereby removing the temptation of manipulating the control.

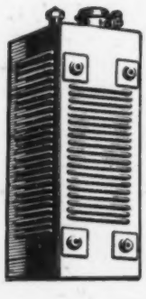
Typical Application:

A manufacturer wanted automatic control of the room temperature of his plant which he heated by unit heaters. He installed a series of Jefferson tamper-proof Air Switches, one for each unit heater, choosing locations which reflected average conditions. These controls served to start and stop the fan motors of the unit heaters as the temperature of the room fell or rose above that for which they were set.

In addition, in order to prevent the fans from operating when no heat was present in the system he installed a surface control on each unit heater—with the mercury contact in the inverted position—so that the fan motor circuit could not be closed if the unit heater was cold.

Because of the absence of knobs on the Air Switch Controls the system was fool-proof, automatic and dependable.

JEFFERSON TEMPERATURE *Controls*



● Delays are not as dramatic as fires—but oftentimes just as costly. Most modern production is built around the timely movement of materials or parts in process. Delay one operation and you delay many. Have a single industrial truck break down on an important job and sometimes the result will follow all the way down to the month's profit-and-loss sheet. No wonder more than half the industrial material-handling trucks are powered by steel-alkaline batteries.

Invented by Thomas A. Edison, the steel-alkaline battery is not only an important advance over the gasoline engine where smooth, certain operation is required—but it also represents a tremendous improvement over all other batteries. It is not subject to sudden failure—doesn't sulphate—stands jars and knocks because it's built of steel—lives 2 to 5 times longer and is more dependable all its life. Such dependability might be worth a big premium—but the per-year cost of the Edison Steel-Alkaline Battery is actually least of all.

EDISON STORAGE BATTERY

DIVISION OF THOMAS A. EDISON, INC., WEST ORANGE, NEW JERSEY

CROUSE-HINDS

High Efficiency

FLOODLIGHTS

Will Solve Many of Your Difficult Lighting Problems

Floodlights not only soon pay for themselves as efficient projectors of light to cover large outdoor areas, but find many applications on the inside of steel mills. There are many important points where high intensity lighting is invaluable and yet is difficult to get with conventional overhead lighting fixtures. Crouse-Hinds type ADE floodlights with their wide range of beam control will fit any of these applications. These compact and sturdy units are dust-tight and weatherproof and constructed entirely of corrosion-resisting metal. They can be provided with various types of mountings so that the proper base may be selected for each particular installation.

A Crouse-Hinds representative will gladly assist in planning a solution to difficult and unusual lighting problems.

Send for Floodlight Catalog No. 316

Type ADE-16

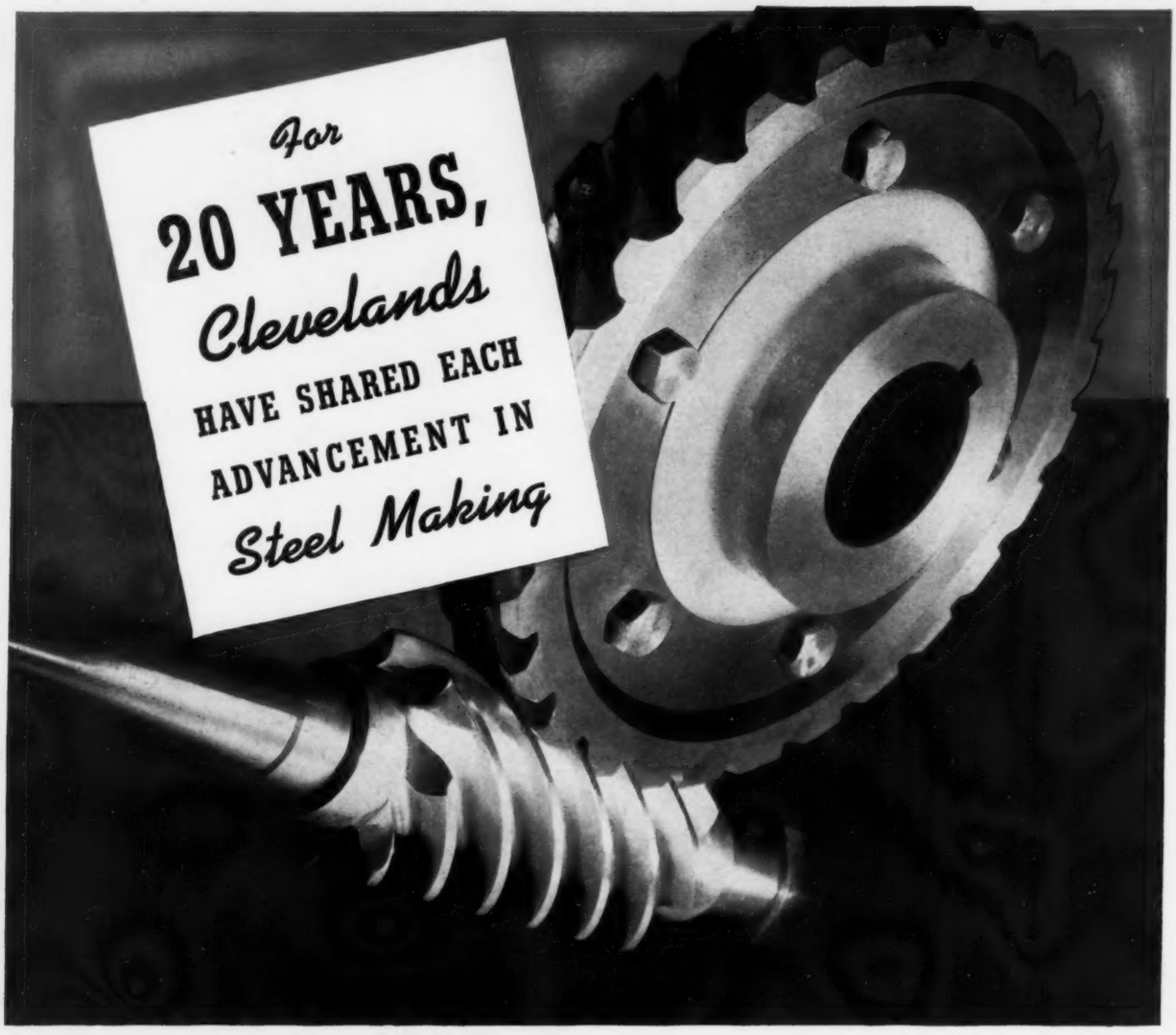
A Nationwide Distribution Through Electrical Wholesalers

CROUSE-HINDS COMPANY

SYRACUSE, N. Y., U. S. A.

Sales Offices: Atlanta — Boston — Chicago — Cincinnati — Cleveland — Dallas — Detroit — Houston — Kansas City — Los Angeles — Milwaukee — Minneapolis — New York — Philadelphia — Pittsburgh — San Francisco — Seattle — St. Louis — Washington

CH640



THE Steel Industry has been a substantial user of Cleveland Worm Gear Speed Reducers ever since 1917. Demands for Clevelands have grown in proportion to size and diversity of equipment employed in modern steel production. The confidence of Management in steel plants that Clevelands will deliver volume power under all conditions, has been continually justified.

Cleveland Worm Gear Drives are thus the industry's popular choice for literally hundreds of separate uses because this Company has applied itself for a quarter century to building Worm Gearing exclusively, under continuous engineering and design research and in a plant largely tooled with equipment made to order.

Clevelands operate for 10, 15 or more years, even in the Steel Industry, with practically no wear or maintenance expense.

Cleveland Representatives in important steel manufacturing districts are in touch with your Engineers, or will gladly call upon request. The Cleveland Worm & Gear Company, 3278 E. 80th St., Cleveland, Ohio.

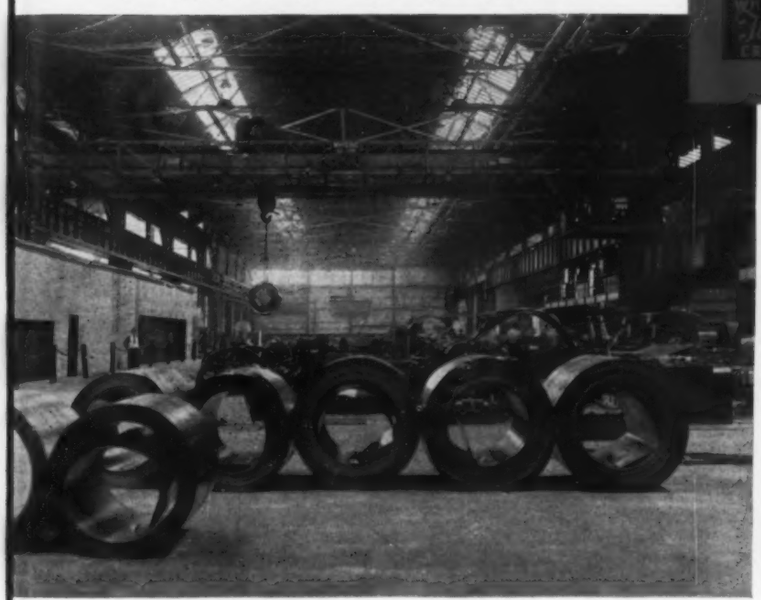
Affiliate: The Farval Corporation, Cleveland, Manufacturers of Centralized Systems of Lubrication

★ CLEVELAND *Worm Gear Drives*

LOW-COST OVERHEAD HANDLING WITH TIGER ELECTRIC TRAVELING CRANE

15-ton, 120-ft. span, Whiting Steel Mill Crane in finishing department.

15-ton, 120-ft. span, Whiting Steel Mill Crane in finishing and shipping department.



20-ton, 90-ft. span, Whiting Steel Mill Crane in cold reduction department.

15-ton, 90-ft. span, Whiting Steel Mill Crane in hot strip finishing department.

Quick action, coupled with dependable low-cost operation make Tiger steel mill cranes the ideal overhead handling unit in any department of the modern steel mill. Continuous, speedy service, at a minimum of operating and maintenance cost, account for the Tiger's ready acceptance in the newest mills. Choose a Tiger for your next crane job.

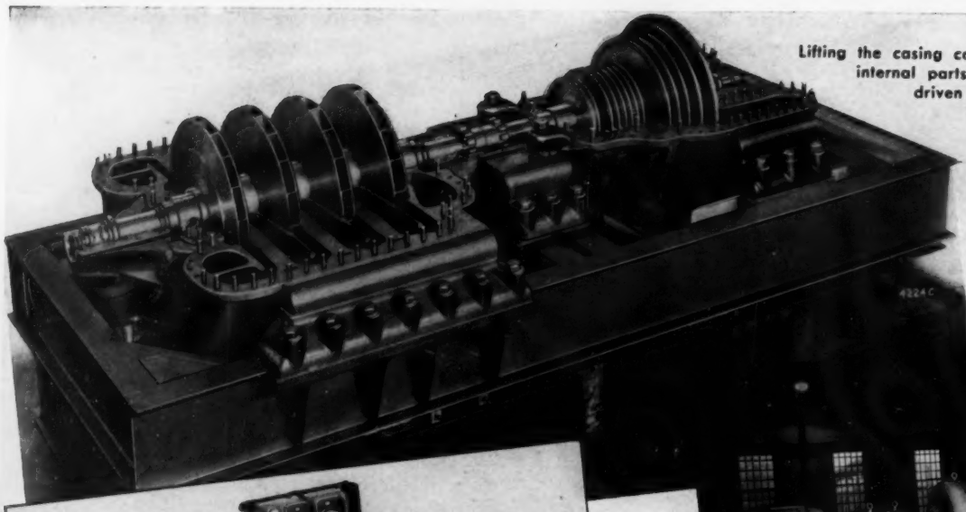
Catalog No. 300 on request.

WHITING CORPORATION • 15655 Lathrop Avenue • HARVEY, ILLINOIS

Electric Traveling Cranes
Foundry Equipment
Railroad Equipment
Pulverized Coal Machinery
Stokers — Special Machinery

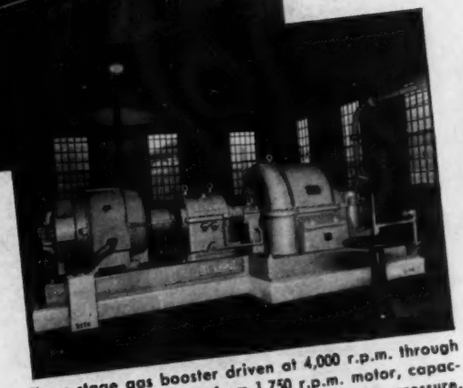
WHITING

PIONEERS SINCE 1884

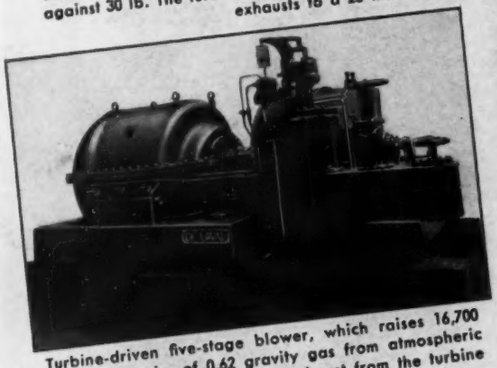


Lifting the casing covers gives access to all internal parts of a De Laval turbine-driven compressor unit.

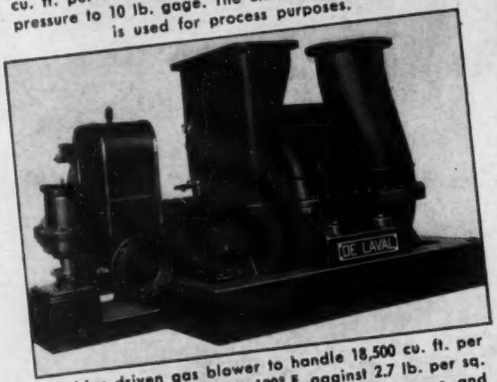
Blast furnace blower to deliver 75,000 cu. ft. per min. of free air at 60° F. against 30 lb. The turbine receives steam at 400 lb. gage and 700° F. and exhausts to a 28 in. vacuum.



Three-stage gas booster driven at 4,000 r.p.m. through speed increasing gear from 1,750 r.p.m. motor, capacity 16,650 cu. ft. per min. against 7 lb. pressure.



Turbine-driven five-stage blower, which raises 16,700 cu. ft. per min. of 0.62 gravity gas from atmospheric pressure to 10 lb. gage. The exhaust from the turbine is used for process purposes.



Turbine-driven gas blower to handle 18,500 cu. ft. per min. of coke oven gas at 100° F. against 2.7 lb. per sq. in. The turbine receives steam at 450 lb. gage and exhausts at 150 lb. into the steam header supplying two previously installed De Laval units of the same capacity. The exhaust from the original units is supplied to the process under 10 lb. back pressure, making the fuel cost of operating the blowers almost negligible.

DE LAVAL

BLOWERS and EXHAUSTERS

for blast furnace and by-product coke-oven plants, and wherever gases are handled in medium and large volumes against pressures up to 100 lbs. per sq. in., have proved themselves to be highly efficient and reliable.

De Laval steam turbine driven exhausters, blowers and compressors are designed, built, tested and guaranteed by one and the same organization, and utilize modern developments in materials, engineering and methods of construction throughout. American industry has testified to their satisfactory performance by giving numerous repeat orders. Ask for Catalog F.

DE LAVAL

STEAM TURBINE CO.

TRENTON, N. J.

3804

HYATT protection for your Mill Motors

For Mill Motors by
GENERAL ELECTRIC • WESTINGHOUSE
CROCKER-WHEELER
Hyatts are available, as standard equipment, or for change-overs.

To assure dry windings and proper armature clearance at all times equip your mill motors with Hyatt Roller Bearings.

Hyatt construction permits the simplest kind of mounting giving you a long-lived installation requiring no maintenance beyond the occasional addition of grease lubricant. Hyatt Bearings Division, General Motors Corporation, Harrison, Detroit, San Francisco. Hyatt Roller Bearing Sales Company, Chicago and Pittsburgh.

HYATT *Roller Bearings*

A SINGLE OBJECTIVE . . . . . *Economy*
A SINGLE RESPONSIBILITY IN ACHIEVING IT

The Republic Flow Meters Co. offers a complete manufacturing and engineering service in the field of measurement and control. We will be glad to co-operate with you in the solution of any metering or control problem, whether it involves a single instrument or the automatic control of an entire process or plant. Your inquiries will involve no obligation on your part.

ELECTRICAL FLOW METERS. For metering the flow of steam, water, gas, air, oil, brine, etc. The reading instruments, indicator, recorder and integrator, are remote reading and can be supplied singly or in any combination desired.

MECHANICAL FLOW METERS. A simple mechanical meter, indicating, recording and integrating the flow of fluids.

CO_2 METERS. Provides a continuous record of per cent CO_2 in flue gas measured by the orsat method. Furnished with either mechanical or remote reading indicator and recorder.

DRAFT INSTRUMENTS. Indicating or recording types in single or multiple units. Furnished in all standard ranges of draft and pressure.

THERMOMETERS. A long distance, expansion type thermometer with either single or multiple pen recorder.

LIQUID LEVEL INSTRUMENTS. Remote reading indicators and recorders. Also provided with various types of alarm and control devices.

MULTI-POINT INDICATORS. Will indicate, on separate horizontal scales from two to sixteen units of draft, pressure, flow, temperature, CO_2, etc., in any combination desired.

MULTIPLE RECORDERS. Will record on a wide strip chart from three to six separate records of flow, temperature, CO_2, pressure, etc., in any combination desired.

PANEL BOARDS. Master instrument and control panels are designed and built for any combination of instruments and controls desired.

BOILER CONTROLS. A centralized, automatic system for controlling steam pressure, combustion, furnace pressure, excess pressure, boiler level, etc. Automatically regulates the fuel and air input to a boiler in measured proportions and in a fixed ratio for the entire load range.

DESUPERHEATERS. A venturi type desuperheater wherein the rate of water flow is controlled by the steam flow in correct proportion to reduce the steam temperature to the degree desired.

REGULATING VALVES. Turbine type valves designed for regulating the pressure and flow of liquids and gases including high pressure superheated steam. Built in accordance with A.S.A. standards for all pressures up to 1,500 lbs. per sq. in.

REGULATORS. For the automatic control of pressure, draft, rate of flow, rate of fuel feed, speed of rotation, liquid level, etc. For proportioning two pressures or flows. Regulators may be either air or oil operated.

STEAM ACCUMULATORS. Designed and built to meet your specific requirements for the storage of high and low pressure steam.

DESCRIPTIVE DATA BOOKS MAILED UPON REQUEST

★

REPUBLIC FLOW METERS CO.
2256 DIVERSEY PARKWAY · CHICAGO · ILLINOIS

Use PYLE-NATIONAL

Permanently efficient floodlighting units for dependable lighting *interior or exterior*

Pyle-National high-efficiency floodlight projectors combine the substantial corrosion-proof construction necessary for heavy duty service with weather tight design that minimizes cleaning and other maintenance. These features not only eliminate the need for inside cleaning but maintain the high efficiency light projection. Correct reflector design plus controlled light distribution delivers the maximum of illumination with minimum current consumption.

Pyle-National floodlighting equipment is available in a full range of standard and special types from 100 watt to 5000 watt size, including portable units, narrow beam floodlights, pit lights and utility floodlights, for all requirements of mill lighting.

NEW FLOODLIGHT CATALOG

Forty page book giving detailed information on floodlight equipment with beam efficiency, candlepower, and light distribution data, will be sent on request. Write for Catalog No. 211.

PYLE-NATIONAL

The Pyle-National Company, *General Offices and Works*, 1334-58 North Kostner Avenue, Chicago, Ill. • *Offices:* New York, Baltimore, Pittsburgh, St. Louis, St. Paul, San Francisco

CONDUIT FITTINGS • LOCOMOTIVE ELECTRICAL EQUIPMENT • FLOODLIGHT PROJECTORS

● In the background is the largest steam flying shear in the world, capable of cutting 30 sq. in. of hot steel at speeds up to 900 f.p.m. Compare this giant with the smaller shear in the foreground. Here is a study in contrast, not in size alone, but also in the manifold problems that *size* entails.

In the background of *all* Morgan equipment you will find the close attention to detail that insures success from the first try-out to actual operation under peak loads. And behind Morgan engineering lies the experience of many years of building and improving complete modern rolling mills.

R31

MORGAN CONSTRUCTION CO. • WORCESTER, MASS., U. S. A.

BEWARE THE *Toll of Tradition* .. GO MODERN WITH YALE ELECTRIC TRUCKS

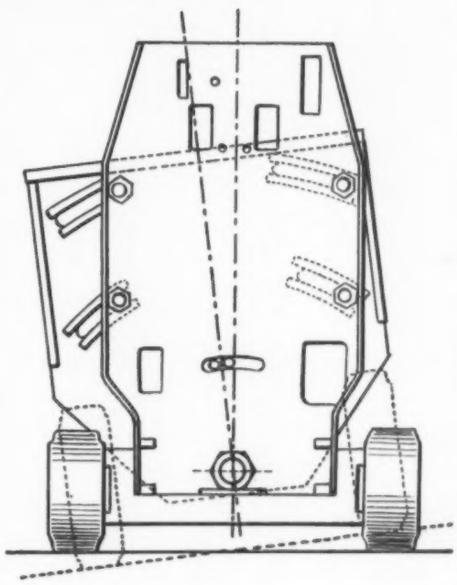
It's not so long ago that lumbering stagecoaches clattered over the highways, paying tribute at every toll gate. The most efficient mode of travel then known—*NOW* relics of a picturesque past... Because time works changes that make the efficiency of yesterday ineffectual today.

That's the price of progress—the reason that materials handling methods which may have brought results for years, fall down when compared to modern systems. One simply has to keep up with the times or pay the Toll of Tradition—excess overhead that bites deeply into profits.

Perhaps therein lies the answer to YOUR cost problem. If so, you can solve it with Yale.

YALE ELECTRIC INDUSTRIAL TRUCKS are the most modern handling equipment in their field. They combine the four features of Safety—Speed—Efficiency and Economy to the Nth degree . . . Bring you the mechanical features of tomorrow—TODAY.

The New Articulated Yale Ram Truck



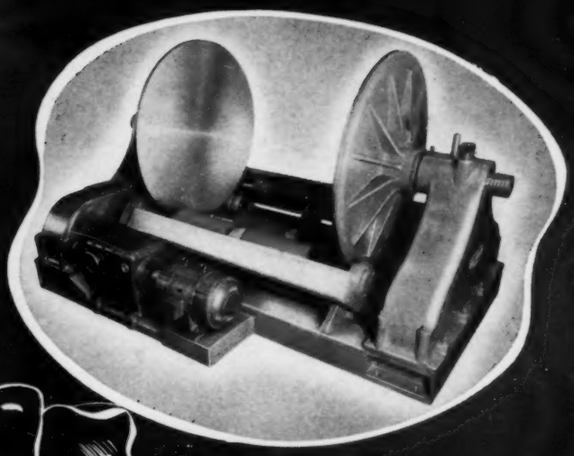
Diagrammatic view illustrating the "Caterpillar Action" of the New Articulated Yale Ram Truck. *THIS FEATURE IS EXCLUSIVE WITH YALE.*

LET OUR REPRESENTATIVE TELL YOU MORE ABOUT THE YALE LINE

TRADE YALE MARK

THE YALE & TOWNE MANUFACTURING COMPANY,
PHILADELPHIA DIVISION, PHILADELPHIA, PA.
IN CANADA: ST. CATHARINES, ONT.

This huge Cleveland Four Point Suspension Press, 18' 8" high, 22' 9" long and 11' 8" wide, does blanking and forming with utmost and constant accuracy. The double roll feed levels and straightens the material before it reaches the dies. It may be used for automatic operation, hand operation or for forward or reverse inching.



This self-contained, cradle type Cleveland Automatic Heavy Duty Uncoiler, in various sizes, takes coils up to 60" wide weighing 10 tons. All rollers continue to bear on the outside of the coil as it decreases in size. The end guides are adjustable to suit various coil widths. The material cannot be scratched or otherwise marred by the rolls.

UNDER CLARK CONTROL

As a tiny mouse ringmaster might easily direct a trained elephant in his feats, Clark "3C" Controls, operated from a push button station, put vast power presses through their paces . . . One small and compact, the other enormous and massive — both sturdy, powerful and effective — both cooperate for long life and low upkeep with uninterrupted production . . . The nearest Clark "3C" representative will gladly consult with you on your electrical control problems.

* * *

AKRON · BALTIMORE · BIRMINGHAM · BOSTON · BUFFALO
CHATTANOOGA · CHICAGO · CINCINNATI · CLEVELAND
DALLAS · DENVER · DETROIT · LOS ANGELES · MINNEAPOLIS
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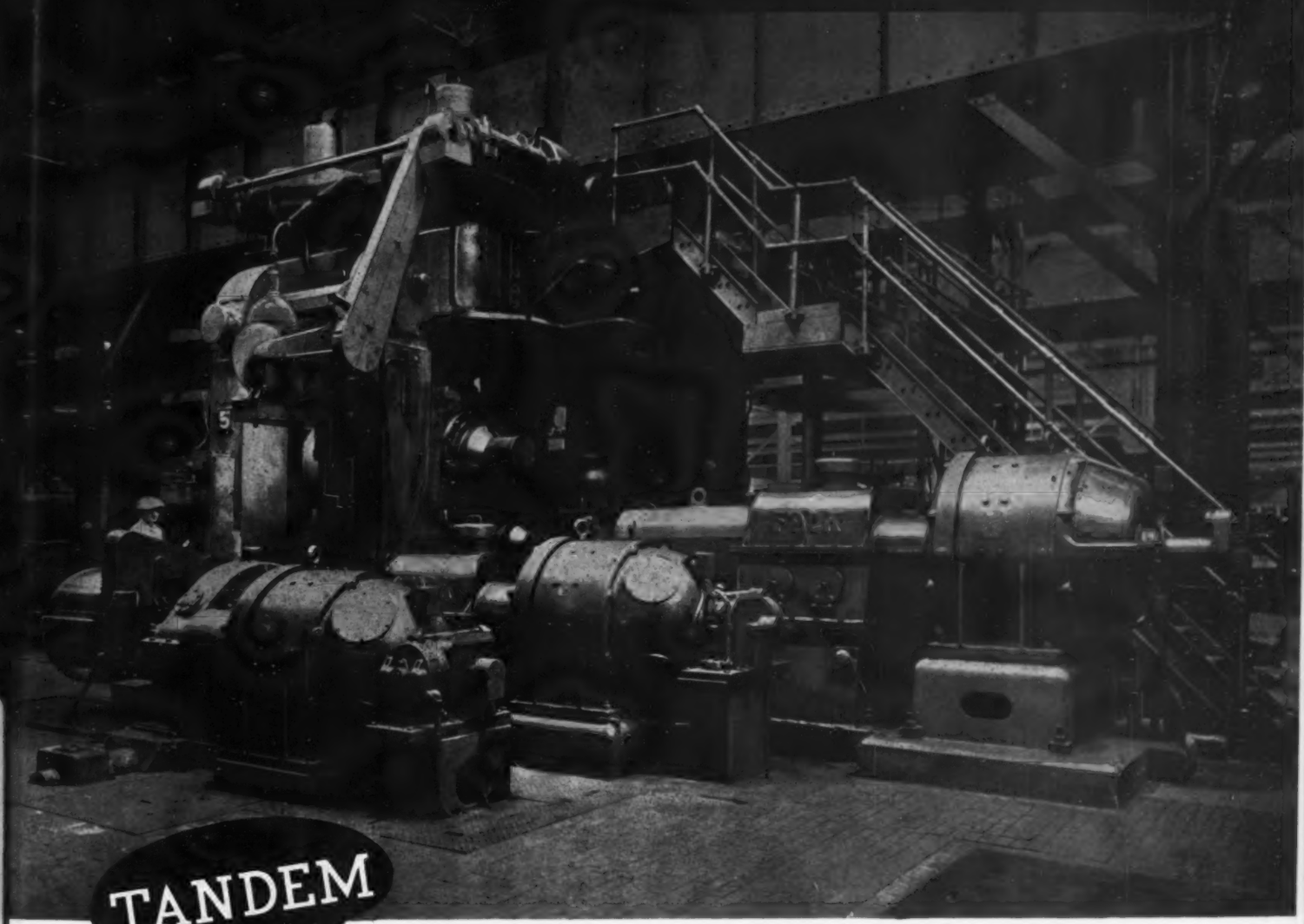
"CLARK 3C" RHEOSTATS · "3C" BRAKES · "3C" A. C. STARTERS · "3C" CONTACTORS · "3C" EDGEWOUND RESISTORS · "3C" D. C. STARTERS · CRANE CONTROLLERS · CRANE PROTECTIVE PANELS · BATTERY CHARGING PANELS · AUXILIARY ELECTRICAL EQUIPMENT.

THE CLARK CONTROLLER COMPANY

1146 EAST 152ND STREET • CLEVELAND, OHIO

THE *Last* STEP



TANDEM TEMPER PASS MILL

These mills are used as the last stage in the rolling process in the production of tin plate. The strip after leaving the hot strip mill passes through the cold reduction mill, is cleaned and annealed in preparation for the temper pass. After the temper pass the steel is sheared to size, white pickled, passed thru the tin bath and cleaned.

The unit shown is a two stand mill with drag reel generators, individual stand motors, tension roll motors and delivery reel motor. This is a total of six machines under automatic control. This control maintains tension on the strip in four places independently and automatically. The tension in each case is adjustable from zero to the maximum, and is constant for all reel diameters and during acceleration and deceleration. The usual coil build up is from 20½" to 48". Mills are in operation with strip speed up to 1500 f.p.m.

805

ELECTRICAL DIVISION

ALLIS·CHALMERS

MILWAUKEE WISCONSIN

Thinking BEYOND

A small matter maybe—but we believe it's just human to put more interest into building a motor for "Brickley & Lane" than for "Order No. 8643"...one reason why the ticket shown below travels with a Reliance Motor in process, carrying the customer's name.

RELIANCE

Under that hat on Sam Dunning there's a heap of useful knowledge about Reliance Motors. In assembly, service work, and other activities he has acquired during his 24 years with Reliance an unusual combination of facts and skill that is peculiarly useful on an assembly floor.

THE ORDER NUMBER

You are not just an order number to the men on the Reliance assembly floor. We know that we are working for you because the job ticket on the motor will have your name on it. They make it a point here to get news along to us about the people who buy and the kind of work the motors will do. A man gets more kick out of putting up a motor for you than for Order No. 7642. Besides, it's not just another motor when we know where it's going and what it's going to do. It's something for an important job like driving a big press in an automobile plant or a calender in a paper mill. » » » If there's something unusual about the job the motor's going on that requires special attention to certain features, the chances are we are told "why" (most men like to know such things).

S. J. Dunning

Foreman of Assembly

Left—Notes on our order ticket can give essential facts but a few words passed along in person stimulate interest. For example, Sam is told: "Blake & Co. are trying this high-speed motor on one of their furnace blowers. It's a tough 24-hour job, but if it works there will be a lot more orders."

Below—Men who build machines like to know what part their work plays in producing the things we wear, read, eat, ride in, etc. These men are looking at pictures posted on our assembly floor which show Reliance Motors operating loaders and conveyors in a coal mine—hard jobs that give motors a real test.

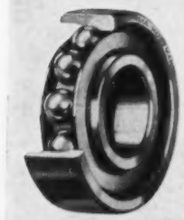
Reliance Electric and Engineering Company • 1088 Ivanhoe Road, Cleveland

Branches: Birmingham, Boston, Buffalo, Chicago, Cincinnati, Detroit, Greenville (S. C.), New York, Philadelphia, Pittsburgh

Representatives in Other Principal Cities

RELIANCE A-C D-C MOTORS

PRECISION BEARINGS



Separable (Magneto) Ball Bearing

FOR EVERY LOAD, SPEED AND DUTY

108 DISTINCT SERIES

BALL, ROLLER AND THRUST

OVER 3000 SIZES

1/8" to 21" Bore—Metric and Inch Sizes

Write for the Catalog and Engineering Counsel

NORMA-HOFFMANN BEARINGS CORP'N.—STAMFORD, CONN., U. S. A.

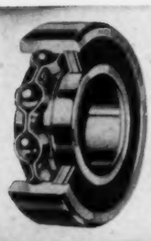
"NORMA-HOFFMANN"

Litro ("CL") Composition Retainer Ball Bearing

Single Row Ball Bearing

Double Row Self-Aligning Ball Bearing

Shielded Type Single Row Ball Bearing

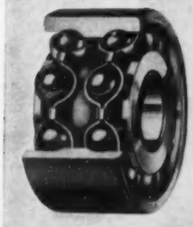


Single Felt Seal Ball Bearing

Double Felt Seal Ball Bearing

9000 Series (Feltless) Sealed Ball Bearing

Cartridge, Fully Sealed, Refillable Type Ball Bearing



Double Row Ball Bearing

Extra Light Type Ball Bearing

Duplex Type (Two Direction) Angular Contact Ball Bearing

Angular Contact Ball Bearing

Single Direction Ball Thrust Bearing

Standard Cylindrical Roller Bearing

Double Row Self-Aligning Adapter Ball Bearing

Full Type (Retainerless) Cylindrical Roller Bearing

Extra Light Cylindrical Roller Bearing

Two-Lipped Cylindrical Roller Bearing

This gentle little creature who is doing his darnedest to shake the gizzard out of the cable may look like a bogey-man, but he's really on your pay roll . . . *because he's costing you plenty of money!* He's an invisible and destructive guest, and you'll always know he's around if you feel vibration quivers when you walk through your mill, factory, power plant, or whatever.

Brittle, dried-out wire insulation is a setup for him. When it's in that condition it falls easy prey to his quivers and shakes . . . cracks appear . . . and the pipe-stem hard insulation falls away. After that anything can happen ranging from a short to a costly equipment and labor tie-up, or even heavy property loss by fire.

But, you can trip the big boy up just as easily as you can order *Rockbestos*. Here's a wire insulated with *asbestos*. It can't dry out or crack because it's heatproof . . . *and that's why it's vibrationproof!* It's flameproof, too, and highly resistant to oil, grease, and corrosive fumes. Perhaps you have a spot in your plant where you can use some as a money-saver? May we send you samples or a catalog? Rockbestos Products Corporation, 870 Nicoll Street, New Haven, Connecticut.

Also refer to Electrical World Buyer's Reference Number for 1938.

ROCKBESTOS A.V.C.—*the wire with permanent insulation*

THROUGHOUT THE STEEL INDUSTRY

POOLE FLEXIBLE COUPLINGS

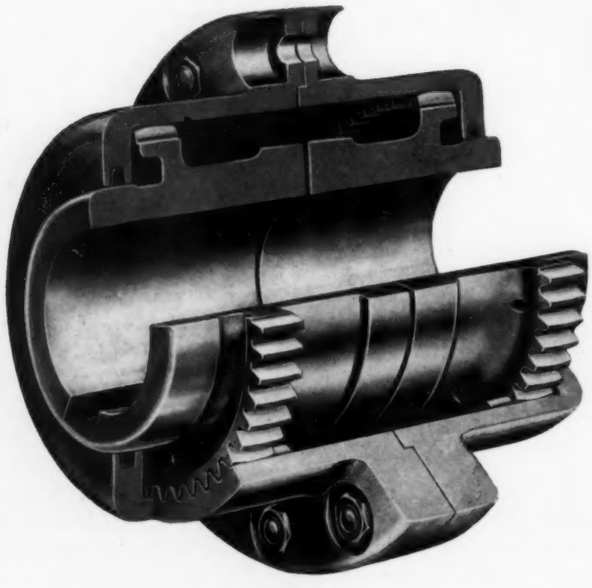
Look at these features—many of them exclusive with the patented Poole:

Adjusts itself to all conditions, leaving its members free to float without strain to parts.

Geared type providing great strength, the highest efficiency of modern flexible coupling design.

No flexing materials to crystalize or break... No welded parts... Filled with oil, self lubricating... Oil tight, dust tight . . . Permits free lateral float . . . Stronger than shafts it connects . . . Compensates for both off-set and angular misalignment.

5000 H.P. MILL DRIVE

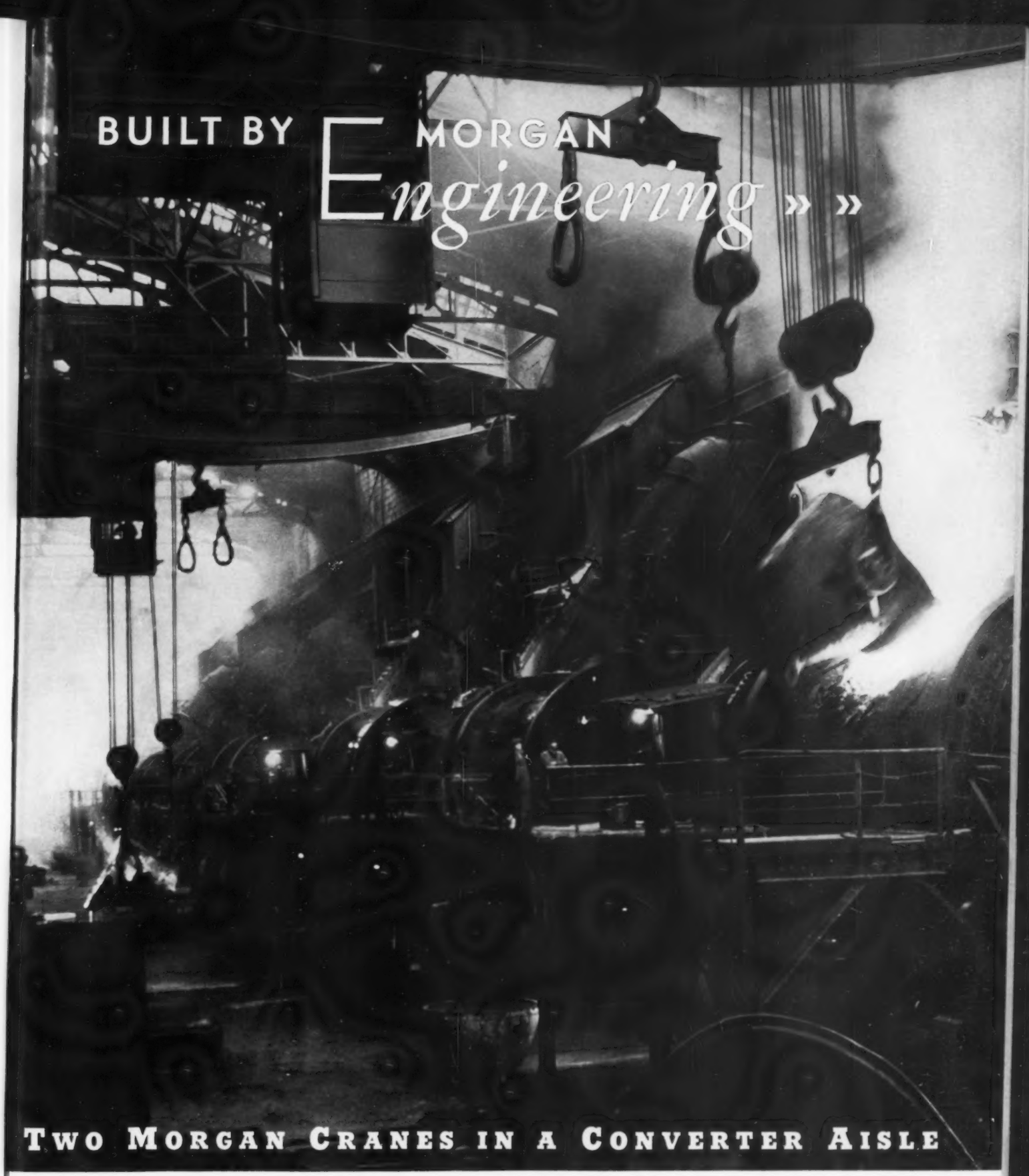


Get the whole story from our handbook, "Flexible Couplings." A copy will be gladly sent without obligation. This book should be in the hands of all "Steel men."

the better
FLEXIBLE COUPLING

Poole Foundry & Machine Company

Baltimore, Maryland



TWO MORGAN CRANES IN A CONVERTER AISLE

● Two 60-ton 66′-0″ span, 4-girder type, ladle cranes with 15-ton auxiliary trolleys, serving a converter aisle, are shown here. Both are equipped with welded fabricated trolleys and bridge trucks, highly efficient type brakes and anti-friction bearings throughout. Morgan engineers, pioneer builders of heavy duty steel mill cranes, are ever alert to accept the newest proved advances in crane construction. In over 55 years of experience, Morgan Engineering has had the opportunity to observe with its customers the lifetime of the huge cranes required in handling hot metal. Longevity of service life is of course based upon sound engineering, the best materials, and correct fabrication methods.

★

DESIGNERS • MANUFACTURERS • CONTRACTORS

★ Blooming Mills • Plate Mills • Structural Mills
Electric Traveling Cranes • Charging Machines
Ingot Stripping Machines • Soaking Pit Cranes
★ Electric Welded Fabrication • Ladle Cranes
Steam Hammers • Steam Hydraulic Forging
★ Presses • Special Machinery for Steel Mills

THE MORGAN ENGINEERING CO.
★ ALLIANCE, OHIO

Pittsburgh, 1420 Oliver Bldg. • New York, 11 W. 42nd St.

★

"FROM THE DAY WE INSTALLED TRICO *Powder-Packed* FUSES WE GOT SERVICE!"

WRITES MR. MAC NEILL

FEDERAL MALLEABLE COMPANY

WEST ALLIS, WISCONSIN
SUBURB OF MILWAUKEE

MALLEABLE IRON CASTINGS
WEAR RESISTING CASTINGS
FRASER RAPPING PLATES
SAND-BLAST NOZZLES

March
Thu
1937

Trico Fuse Mfg. Company
Milwaukee, Wisconsin

Gentlemen:

A record of eighteen months service on a heavy circuit may not be surprising to you, but we are so impressed by the service we have received from a set of 600 ampere Trico Powder-Packed fuses, that we are moved to write you this letter which you can use for any purpose you see fit.

In September, 1935, we installed your fuses on an air compressor circuit which had been blowing various types of 600 ampere link fuses several times a week and as often as twice a day.

The original set of your Trico fuses are still in service and it is needless to say that we are delighted with the saving we have made both in cost of fuses and elimination of shut-downs.

We are very glad to recommend your fuses to anyone who desires dependable and economical service.

Yours very truly,

FEDERAL MALLEABLE COMPANY

W. J. MacNeill
Secretary

WJM/vn

AND THAT LETTER PROVES---

- That **Faulty Fuses—not overloads**—cause most shutdowns.
- That such shutdowns are unnecessary and unjustifiable.
- That experimenting with fuses having the **same kind** of renewal link proved a waste of time and expense.
- That there really are only TWO KINDS of renewable fuses—the Bare Link and the Powder-Packed type.
- That when Mr. MacNeill installed TRICO—the **Powder Packed** kind—safe, efficient and dependable service immediately predominated.
- It proves again that a fuse is **no better than its renewal element** and that it pays to

INSTALL THIS FAMOUS TRICO COMBINATION

STOPS
WASTED KILOWATTS
WASTEFUL SHUTDOWNS

TRICO *Powder-Packed* FUSES

They give better service because they are expressly designed to accommodate TRICO **non-interchangeable** elements only. "Foreign" links will not fit into them. Thus you are assured, year after year, of safe, **tamper-proof** protection with a superior time-lag that only a **powder-packed** element can give. **TRY THEM TODAY!**

KLIPLOK CLAMPS

should be used on all fuses, regardless of make. Eliminate burnt fuses and clips, unnecessary shutdowns and wasted current caused by overheating. KLIPLOKS **correct** bad clips and **protect** new clips. There's a size for every clip.
USE KLIPLOKS EVERYWHERE!

Fully covered by U. S. Patents

YOU NEED GOOD MOTORS—

...to make an I-beam

For the failure of any one of the motors, in any one of the successive steps in the making of steel, will as efficiently stop manufacture as the lack of ore or orders.

It was Crocker-Wheeler that built the first genuine steel-mill motor—back in 1904. The first motor designed exclusively for the Steel Industry.

And today there is a modern line of Crocker-Wheeler motors (form "SW") also designed for the Steel Industry. Used on cranes, hoists and steel-mill auxiliaries these motors help to prevent costly shut-downs—motors that can be installed and then forgotten.

CROCKER-WHEELER

EXCELLENT ENGINEERING

CROCKER-WHEELER ELEC. MFG. CO.

Main Office and Works: AMPERE, N. J.

SALES OFFICES IN PRINCIPAL CITIES

A LOOK *"under the hood"*

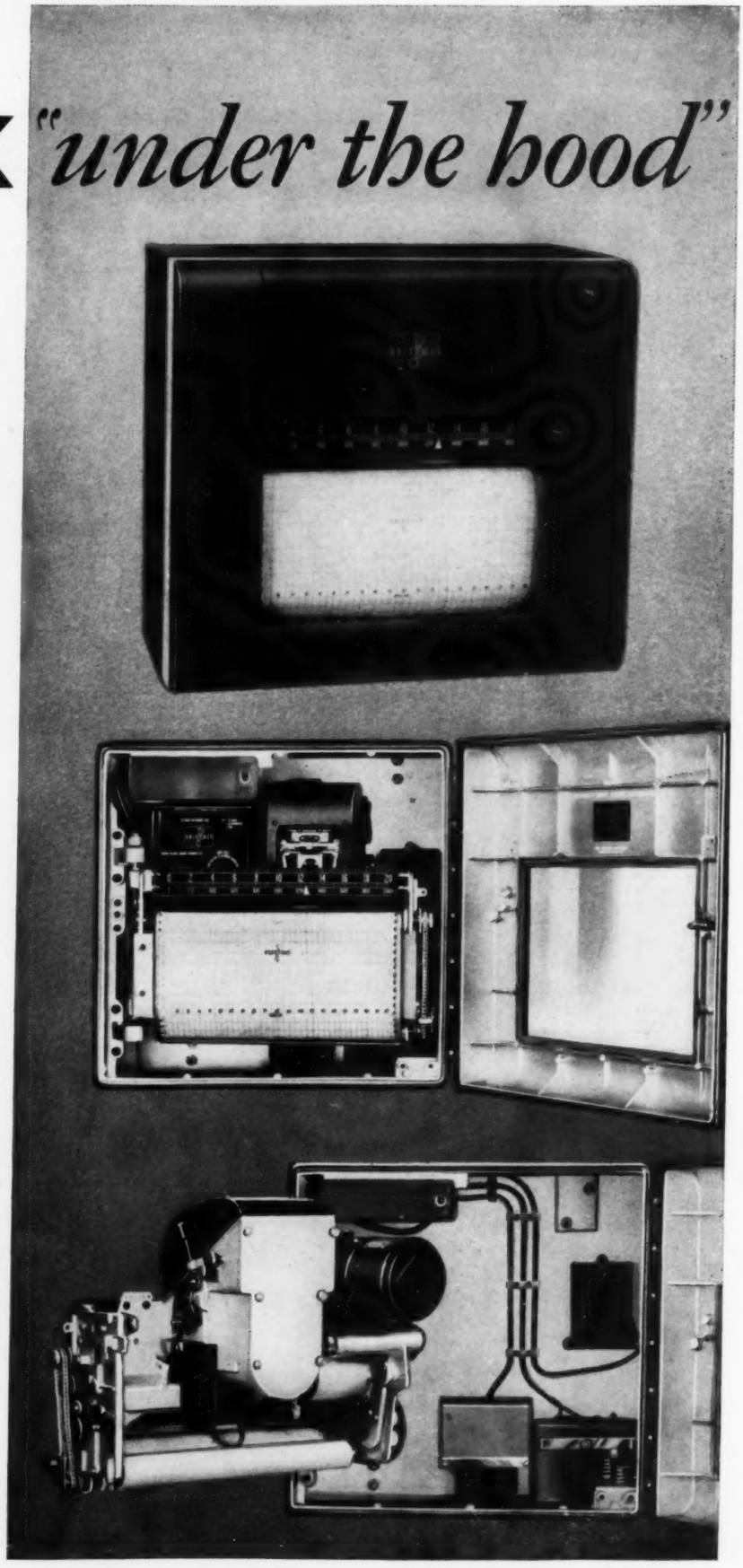
. . . shows this Wide-strip has everything!

WHEN you inspect this new Bristol's Wide-Strip Pyrometer, you can see immediately that here is an instrument you can count on for precision measurement, for reliability, for performance that is in keeping with your most exacting requirements.

Where else, for example, do you find *all* these time-tested features that contribute to good service,—

Totally enclosed galvanometer
Circuit automatically standardized
Electric balancing
No lost motion
Visible operating mechanism
Extra wide 12¼ inch chart
Duplex slide wire accuracy
Large easy to read scale
Automatic cold junction compensator
And nearly a hundred more?

Catalog 1451 Z is the one to write for.



THE BRISTOL COMPANY
WATERBURY, CONNECTICUT

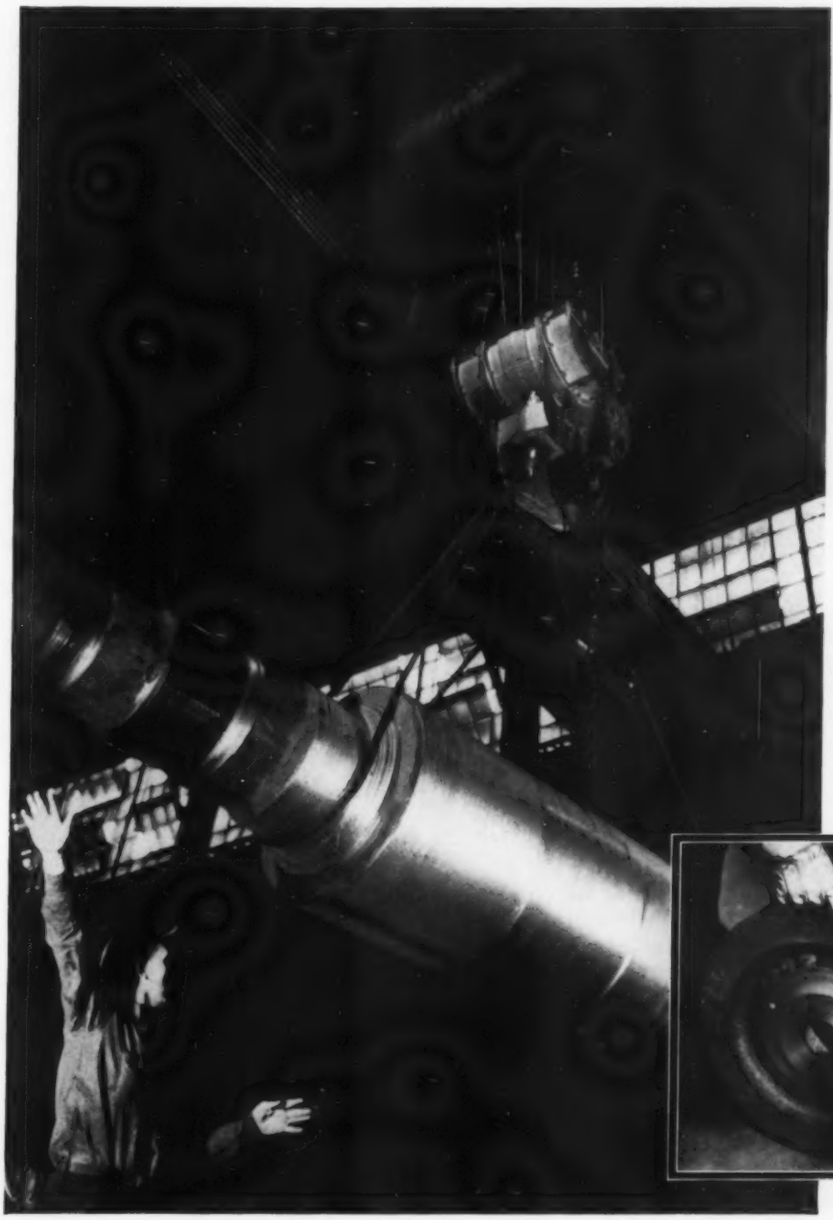
Branch Offices: Akron, Birmingham, Boston, Chicago, Detroit, Los Angeles, New York, Philadelphia, Pittsburgh, St. Louis, San Francisco, Seattle. Canada: The Bristol Company of Canada, Limited, Toronto, Ontario. England: Bristol's Instrument Company, Limited, London, N.W. 10.

BRISTOL'S

TRADE MARK REG. U. S. PAT. OFF.

WIDE-STRIP PYROMETER

What happens when Crane Wheels *take a "Holiday"?*



EVERYBODY loses. When the machine shop closes down for maintenance, you lose profits. Your men lose time. And if deliveries are delayed, your customers lose patience.

To cut this nuisance down to a rock-bottom minimum, machine-shop superintendents are now using USS Wrought Steel "Rim-toughened" Crane Wheels. You'll find them on the largest, best-known cranes in the country, because their record has proved beyond question that they are the finest wheels available, both from the standpoint of safety and economy.

These long-mileage wheels outwear ordinary wheels by approximately 2½ to 1. Specify them both for new equipment and for replacements. You'll appreciate the savings.

USS Wrought Steel Crane Wheels, double flange or single flange, are furnished rough machined, finish machined, or finish machined with finish bore and keyway—rim toughened or untreated, as desired.

Look for the letters "R. T." stamped in the rim. They mean "Rim-toughened" by the USS process to assure lasting hardness, safety, and long wear.

U·S·S WROUGHT STEEL CRANE WHEELS

CARNEGIE-ILLINOIS STEEL CORPORATION

Pittsburgh *Chicago*

Columbia Steel Company, San Francisco, *Pacific Coast Distributors* United States Steel Products Company, New York, *Export Distributors*

UNITED STATES STEEL

RECLAIMED!

. . . at a fraction of replacement cost

Here's the sort of job on which Thermit welding really shows its stuff.

This heavy plate mill housing . . . 22 ft. high and weighing 82 tons . . . fractured in two places. To replace it would have meant not only the expense of a complicated new casting, but also weeks of delay with production held up and overhead steadily mounting.

But the frame was Thermit welded and back in service in little more than a week . . . permanently repaired at a small fraction of replacement cost.

Savings such as this, ranging from 50% to 85%, are typical of Thermit welding for the reclamation of housings, crank shafts, connecting rods, charging peels, manipulator racks, pinion teeth, wabblers, and other parts.

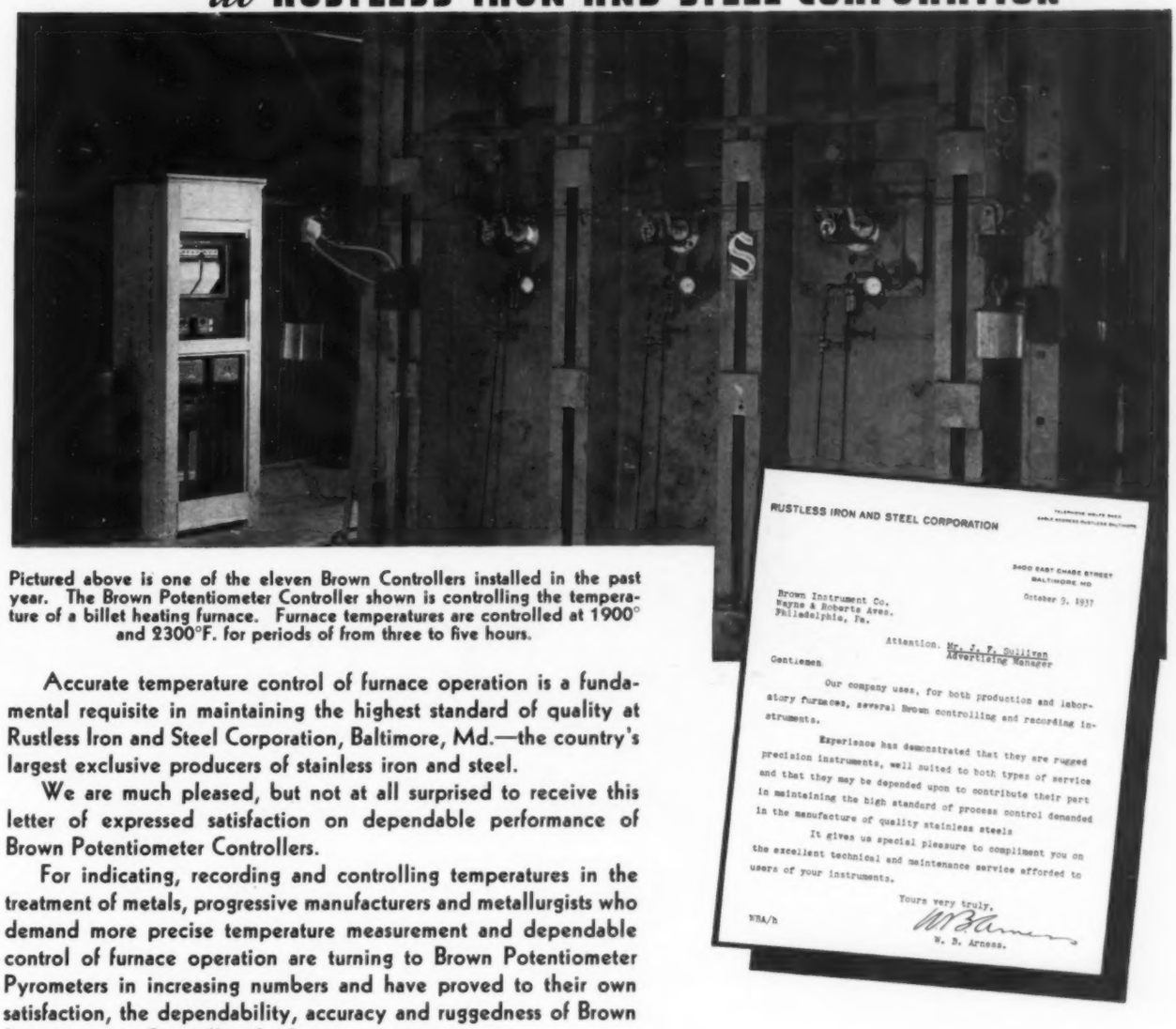
The applications of Thermit welding are innumerable. Let us send you the pamphlet "Thermit Welding—Industry's Master Maintenance Tool," containing details of methods and other information.

THERMIT WELDING

METAL & THERMIT CORPORATION, 120 BROADWAY, NEW YORK, N. Y.

ALBANY • PITTSBURGH • CHICAGO • SOUTH SAN FRANCISCO • TORONTO

Keeping Pace with Progress
at RUSTLESS IRON AND STEEL CORPORATION



Pictured above is one of the eleven Brown Controllers installed in the past year. The Brown Potentiometer Controller shown is controlling the temperature of a billet heating furnace. Furnace temperatures are controlled at 1900° and 2300°F. for periods of from three to five hours.

RUSTLESS IRON AND STEEL CORPORATION

October 9, 1937

Brown Instrument Co.
Wayne & Roberts Aves.
Philadelphia, Pa.

Attention. Mr. J. P. Sullivan
Advertising Manager

Gentlemen:

Our company uses, for both production and laboratory furnaces, several Brown controlling and recording instruments.

Experience has demonstrated that they are rugged precision instruments, well suited to both types of service and that they may be depended upon to contribute their part in maintaining the high standard of process control demanded in the manufacture of quality stainless steels.

It gives us special pleasure to compliment you on the excellent technical and maintenance service afforded to users of your instruments.

Yours very truly,

WBA/h

W. B. Arness.

Accurate temperature control of furnace operation is a fundamental requisite in maintaining the highest standard of quality at Rustless Iron and Steel Corporation, Baltimore, Md.—the country's largest exclusive producers of stainless iron and steel.

We are much pleased, but not at all surprised to receive this letter of expressed satisfaction on dependable performance of Brown Potentiometer Controllers.

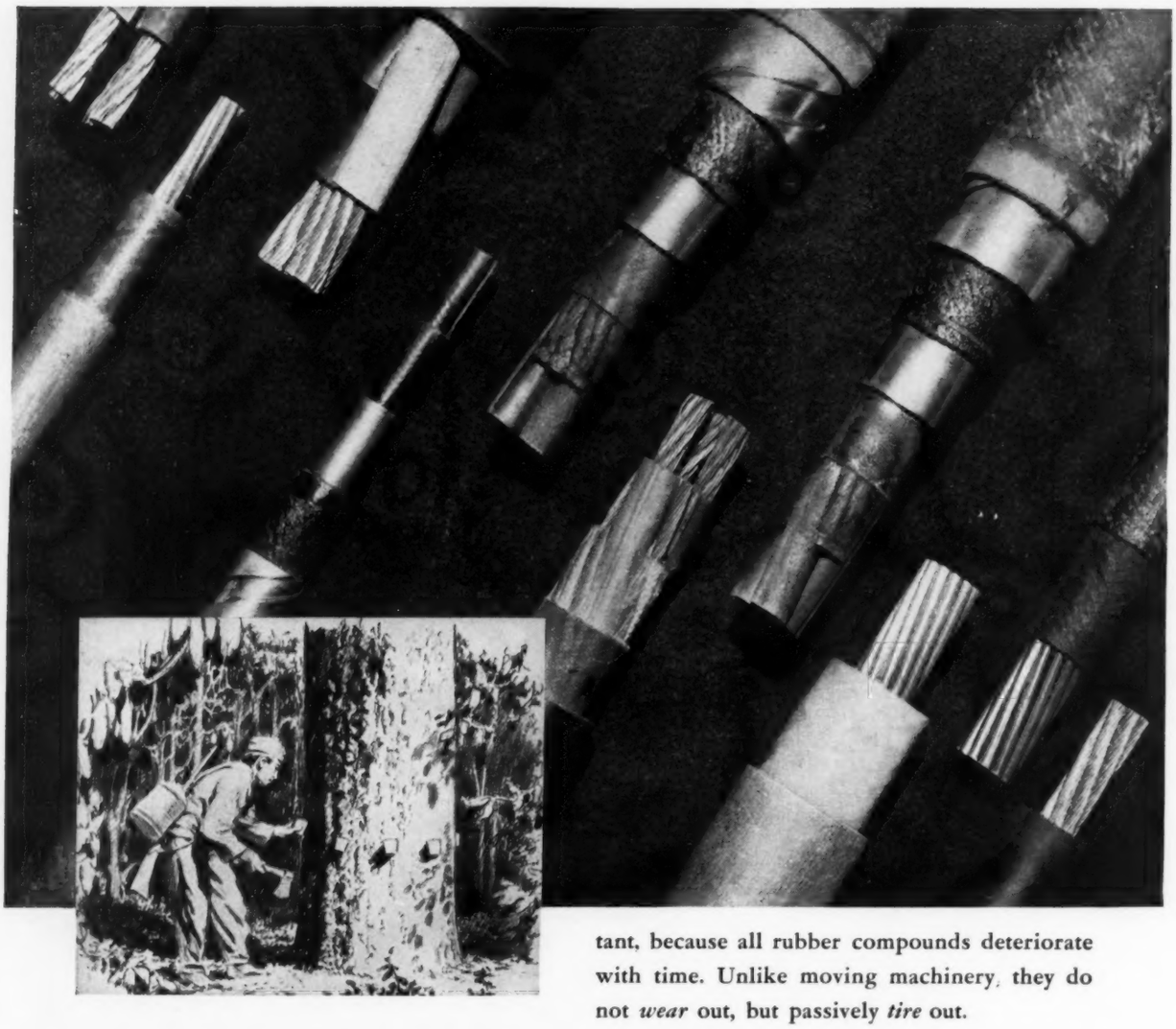
For indicating, recording and controlling temperatures in the treatment of metals, progressive manufacturers and metallurgists who demand more precise temperature measurement and dependable control of furnace operation are turning to Brown Potentiometer Pyrometers in increasing numbers and have proved to their own satisfaction, the dependability, accuracy and ruggedness of Brown Potentiometer Controllers for heat treating processes.

When you install Brown Potentiometer Pyrometers, you can rely on their precision—be confident of their dependability. Why not learn more about Brown Potentiometer Pyrometers—how they can aid you in simplifying heat treating processes. Catalog No. 1102 . . . just off the press . . . describes in full detail, models and outstanding features of both electric and air-operated Brown Potentiometer Pyrometer Controllers. Write for a copy. THE BROWN INSTRUMENT COMPANY, *a division of Minneapolis-Honeywell Regulator Co.*, 4464 Wayne Avenue, Philadelphia, Pa. Offices in all principal cities. Toronto, Canada: 117 Peter Street—Amsterdam-C, Holland: Wijdesteeg 4—London, England: 70 St. Thomas' Street, S.E. 1.

BROWN POTENTIOMETER CONTROLLERS
and
MINNEAPOLIS-HONEYWELL CONTROL SYSTEMS

To Measure and Control is to Economize

Insulation from Age-old Trees



The finest of all rubbers for electrical insulation is found only in the jungles of the Amazon. When properly mixed with chemically pure fillers and properly vulcanized, it makes a rubber compound that is less subject to deterioration than any other rubber compound. This is very important, because all rubber compounds deteriorate with time. Unlike moving machinery, they do not *wear* out, but passively *tire* out.

Okonite utilizes exclusively this Wild, Up-river Fine Para rubber. This is one of the reasons why Okonite lasts so long in hard services and is so dependable. And *that* is why Okonite is found on so many railroads where long, dependable service is of first importance.

THE OKONITE COMPANY

Founded 1878

HAZARD INSULATED WIRE WORKS DIVISION

THE OKONITE-CALLENDER CABLE COMPANY, INC.

EXECUTIVE OFFICE: PASSAIC, N. J.

New York Boston Seattle Buffalo Chicago Dallas Detroit Atlanta
Philadelphia Los Angeles Pittsburgh St. Louis Washington San Francisco

Factories: Passaic, N. J. Wilkes-Barre, Pa. Paterson, N. J.

Setting New Braking Standards in Steel-Mill Service

NO MATTER OF CHANCE... the standardization of J-M Friction Materials on steel-mill hoists, cranes and similar equipment. Over a long period of years, these products have *proved* their durability and dependability under the severe service conditions typical of the steel industry.

And because Johns-Manville research and rigid manufacturing control guarantee *consistently* high quality, J-M Brake Linings and Clutch Facings offer every assurance of new maintenance and power economies.

Both flexible and rigid styles to answer every steel-mill need are available in J-M's complete line of friction materials. Get full details on all of them by writing for our brochure, "Friction Materials for the Iron and Steel Engineer." Address Johns-Manville, 22 E. 40th St., N.Y.C.

JM Johns-Manville
Industrial Friction Materials

AN EFFECTIVE METHOD OF REDUCING OPEN HEARTH COSTS

● Open hearth furnaces pay a greater return on the investment when equipped with Bailey Control. This air-operated control system automatically maintains constant Furnace Pressure and most economical Fuel—Air Ratio consistent with furnace life.

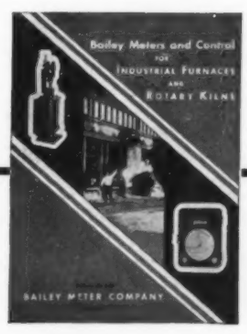
Peak flame temperature is assured by Bailey Control as the result of correct excess air for combustion and reduction of unregenerated air infiltration to a minimum. Rapid deterioration of refractories is prevented prolonging the length of campaigns. The number of b. t. u. per ton of steel is lowered.

Details on how Bailey Control can shorten heats, lengthen campaigns, and decrease fuel consumption of your open hearth furnaces will be furnished upon request.

Mail coupon today

Send for this New Bulletin

BAILEY OPEN HEARTH CONTROL



S-5

BAILEY METER COMPANY
1047 IVANHOE ROAD, CLEVELAND, OHIO
CANADIAN ADDRESS • MONTREAL, CANADA

Gentlemen: Kindly send me a free copy of Bulletin No. 104 describing Bailey Open Hearth Furnace Control.

Name_____

Company_____

Street_____

City_____ State_____

KNOWING THE CO_2 CONTENT IS YOUR GUIDE

HAYS CO_2 RECORDER

Knowing the exact condition of the atmosphere in a heat treating furnace is vital in securing the results wanted.

For instance one user of a Hays CO_2 Recorder found that if the CO_2 content of his furnace was too high it had a case hardening effect upon his product due to absorption of carbon from the CO_2 which was disastrous to the quality of his product. On the other hand, too low a CO_2 content meant a serious fuel loss which he was anxious to avoid. Another user needs a neutral atmosphere to avoid oxidization and possible rusting of his product.

Wherever there is a heat-treating furnace there is the real need for a CO_2 Recorder or Orsat Analyzer.

The Hays CO_2 Recorder operates on the reliable Orsat principle of volumetric measurement and chemical absorption. Also records pressure, differential, draft, and temperature. Send for complete new catalog just off the press.

MAIL THIS COUPON

7-11-7

MAIL THIS COUPON

☐ Send New Catalog on CO_2 Recorders.
☐ Send late Catalog on Hays Draft Gages.

Individual _____

Title _____ Firm _____

Street & No. _____ Town _____

The HAYS CORPORATION

COMBUSTION INSTRUMENTS AND CONTROL

MICHIGAN CITY, INDIANA, U.S.A

"Vibration Proof" Lubricant

Prevents Oil-Soaked Windings

On Steel Mill Motors

Ordinary oil leaks or creeps from bearings shortly after being applied. Where there is vibration these faults are aggravated — the oil is actually thrown off and wasted — or worse still, it gets on windings causing short circuits.

NON-FLUID OIL does away with such troubles because it clings to metal and stays in bearings until entirely consumed. It not only prevents short circuits—because it stay off windings, but it outlasts liquid oil 3 to 5 times, reducing both lubricant and application cost.

Send for testing sample today—prepaid—NO CHARGE.

•

New York & New Jersey Lubricant Co.

Main Office: 292 Madison Ave., New York, N. Y.

WAREHOUSES:

Chicago, Ill.
St. Louis, Mo.
Providence, R. I.
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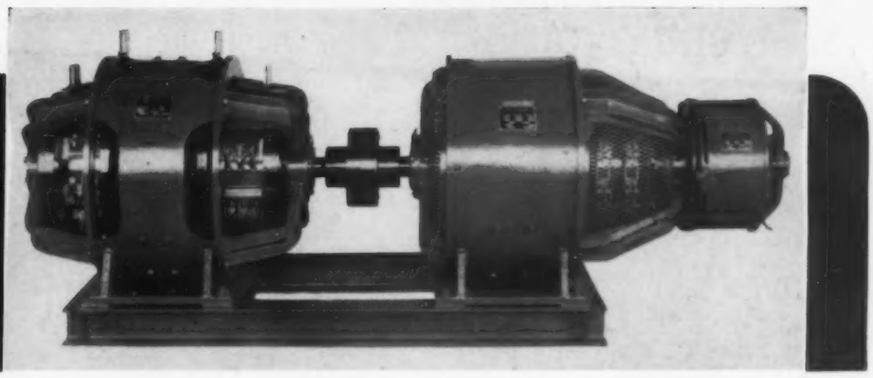
TRADE MARK REGISTERED
NON-FLUID OIL
IN U.S. PAT OFFICE & FOREIGN COUNTRIES

MODERN STEEL MILL LUBRICANT

Better Lubrication at Less Cost per Month

DEPENDABLE LOW VOLTAGE GENERATORS



Today's highly finished metal and plated strip steel require real skill in the cleaning, pickling and plating departments. They also demand the best in low-voltage generators.

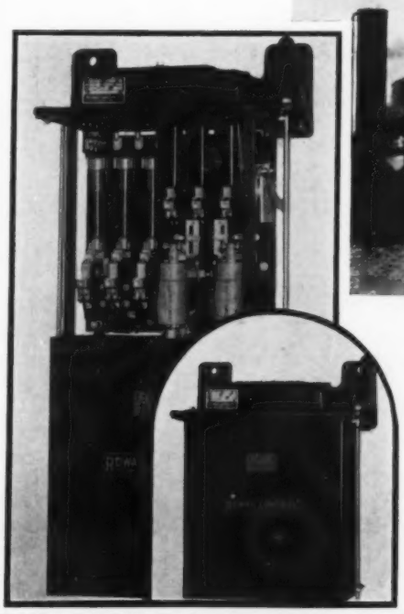
Columbia Low Voltage Generators are built to stand up under the continuous full-load operation of present day requirements. They are modern in every detail and conservatively rated. Prompt deliveries can be made on standard Columbia 6 to 12 volt generators and voltage ratings up to 45 volts can be furnished. Capacities range from 100 to 20,000 amperes with synchronous or induction motor drive. Complete information on any size will be furnished promptly.

The Tong Test Ammeter is the only instrument which will measure both A.C. and D.C. currents instantly, accurately and without breaking the circuit. It is equipped with quickly interchangeable meter dials to measure up to 800 amperes. May we send you a copy of the bulletin describing Tong Test and its many uses?

COLUMBIA ELECTRIC MFG. COMPANY, 4505 Hamilton Ave., CLEVELAND, OHIO

ROWAN OIL IMMERSED CONTROL

Is supplied in many types for the requirements of industry.



Rowan engineers have spent a quarter of a century in the development of oil immersed control equipment for electric motors which operate in dirty, corrosive and hazardous atmospheric locations. Write for specifications on oil immersed control equipment to meet your particular requirements.

Left—Type 780-KBF combination across-the-line A. C. motor starter.

ROWAN CONTROL
THE ROWAN CONTROLLER CO., BALTIMORE, MD.

For trouble-proof service, make your next contract read *Pennsylvania*

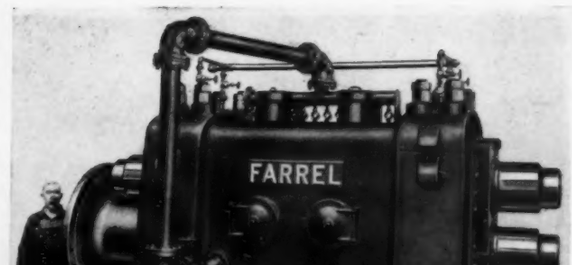
PENNSYLVANIA is rapidly forging to the front as a builder of high-quality distribution transformers. Those interested in engineering, operating or maintenance will readily appreciate the outstanding advantages of basic improvements such as these:

- ▲ Coils of circular shape, the same as in power transformers, balanced radially and axially against short-circuit stresses;
- ▲ Treatment of coils in varnish—not compound—(made possible by open-type construction) at temperature not exceeding 105°c, thus assuring safe, pliable insulation;
- ▲ Low temperature gradient between copper and oil, which permits greater overloads with safety;
- ▲ Stud Type Bushings brought out through pockets and bolted from exterior, giving maximum accessibility;
- ▲ Insulation fully co-ordinated with flash-over of bushings, resulting in complete surge-resisting qualities.

It will pay you to consider Pennsylvania Distribution Transformers before placing your next contract.

PENNSYLVANIA TRANSFORMERS

PENNSYLVANIA TRANSFORMER CO.
1701 ISLAND AVE., N. S.
PITTSBURGH, PA.



WELDED PINION STAND TRANSMITS 4000 H.P.

The all-steel construction of this pinion stand combines castings and plates welded together into a substantial unit capable of withstanding the severe shocks encountered in steel rolling mill drives.

The unit transmits 4,000 H.P. at 77/154 R.P.M. to a 20″ and 52½″ x 72″ Four-High Reversing Cold Strip Finishing Mill.

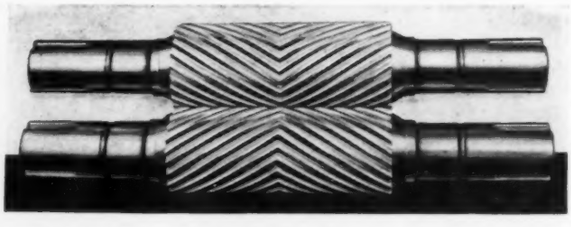
The pinions are single helical, 20″ diameter, 50″ face, mounted in steel-backed, babbitt-lined bearings. Pinions and bearings are pressure lubricated by separate systems. The pinion lubricating system is provided with steam-jacketed piping to soften the heavy lubricant required for the pinions.

This is an example of the "engineering-to-fit-the-job" of Farrel Rolling Mill Drive Units. We build drives and pinion stands to your specifications and are prepared to furnish Sykes continuous tooth herringbone pinions or single helical pinions, welded or cast cases or both combined, and other details to fit individual requirements.

FARREL-BIRMINGHAM COMPANY, INC.

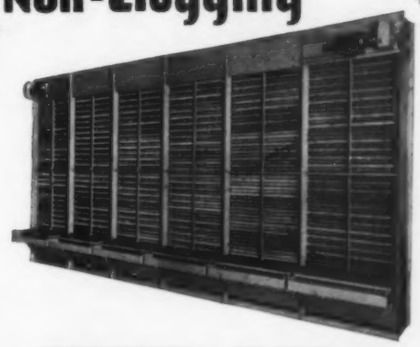
42 Main Street, Ansonia, Conn.
366 Vulcan Street, Buffalo, N. Y.

Below—Sykes continuous tooth herringbone pinions are precision generated for smooth operation and durability.



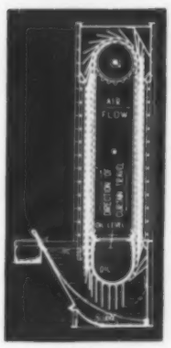
SELF-CLEANING Non-Clogging

— true impingement — maintenance free — air filtration, ranging capacities from 3,000 CFM. to 600,000 CFM. The DOUBLE-DUTY operates automatically — affords constant unvarying air flow — six acute deflections thru curtains and double surface usage of plates. Designed for Industrial and Large Building installations.



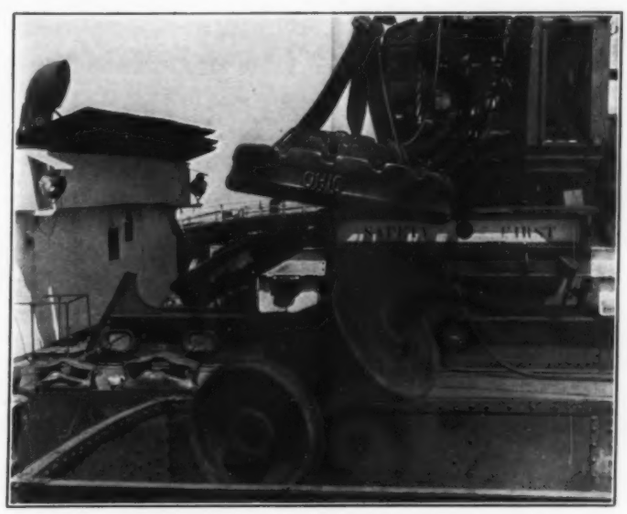
DOUBLE DUTY
Air Filtration

Note the simplicity of construction of this all steel filter and free swinging action of plates affording self-cleaning feature.



"INDEPENDENT"

INDEPENDENT AIR FILTER COMPANY
228 NORTH LASALLE STREET CHICAGO, ILLINOIS
Representatives in all principal cities



Ships make no money in port. Ohio Magnets help many Lake and Ocean Ships to load and unload rapidly.

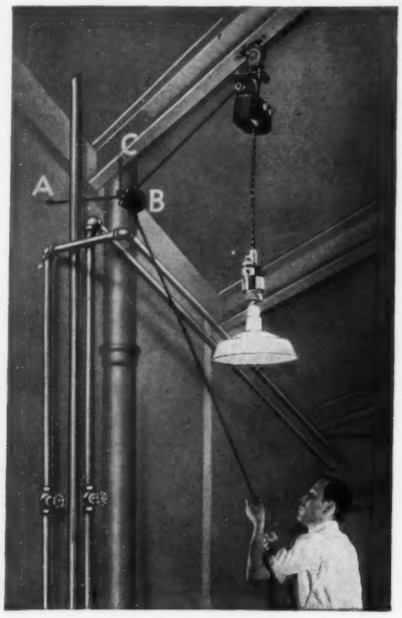
Above we see an Ohio 65" Magnet unloading the steamer Lagonda of The Pickands Mather Fleet.

It is getting from 5 to 7 old 700-pound car wheels per lift.

There is no faster way.

Ask for Bulletin No. 110

THE OHIO ELECTRIC MANUFACTURING CO.
5907 Maurice Ave. Cleveland, Ohio



DIRT

on the business side of the reflector

—is the greatest handicap to good lighting.

Accessibility is one of the most important things in reflector cleaning.

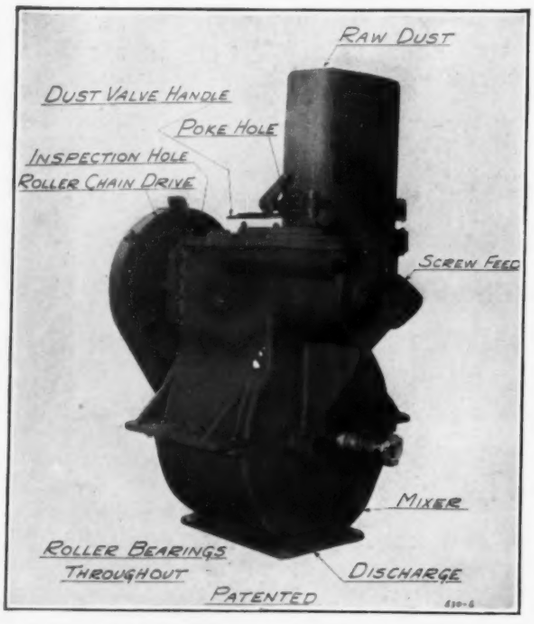
THOMPSON LAMP LOWERING HANGER

—enables overhead lamps to be serviced with ease and in safety on the ground or floor level—automatically locked in the electric circuit when pulled up again—the advantage is obvious—inexpensive and easily included in present installations.

Handled by leading Electric Supply Houses

THE THOMPSON ELECTRIC CO.

1101 POWER AVENUE, N. E. CLEVELAND, OHIO, U. S. A.



BROSIUS FLUE DUST CONDITIONER

One Ohio Blast Furnace Plant, using one of our latest machines, conditions the dust from a Vortex dry cleaner at the rate of 120 tons of conditioned dust per hour and does an excellent job with a very low maintenance cost. This dust is extremely fine, as much as 30% going through a 300 mesh screen.

The Brosius Conditioner conditions the dust directly at the dust catcher, making it ready for the sintering plant. The sensible heat is removed and the dust conditioned by being passed through a rotating cage fitted with a series of bars which agitate the dust and mix it with water. Any degree of moistening can be obtained as the amount of moistening is governed by the amount of water supplied.

It is a self contained unit and overcomes dust nuisances always present when emptying untreated dust from the dust catcher. It cuts plant operating costs by eliminating the labor required to clean up after emptying untreated dust, and saves wear and tear on cars caused by loading hot dust.

OTHER PRODUCTS

Electric, Steam and Hydro-Electric Clay Guns,

Hand and Motor Operated Goggle Valves,

Cinder Notch Stoppers,

Blast Furnace Slag Granulating Machines,

Soaking Pit Cover Carriages.

EDGAR E. BROSIUS, INC.

Engineers and Manufacturers

PITTSBURGH, SHARPSBURG BRANCH, PENNSYLVANIA

European Distributor

Dango & Dienenthal, Siegen, Westphalia, Germany

Brosius Equipment is patented in the United States and Foreign Countries

OTHER PRODUCTS

Single Hook Grab Buckets,

Automatic Dump Buckets,

Automatic Single Hoist Buckets,

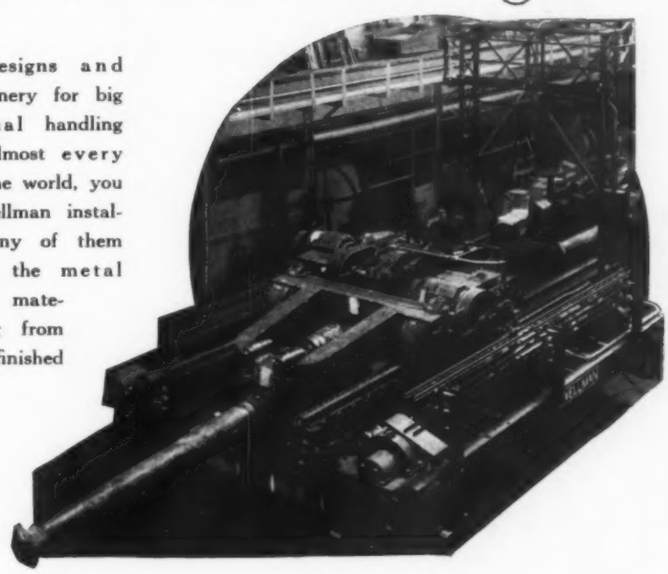
Auto Floor Charging Machines,

Overhead Charging Machines,

Auto Floor Manipulators.

Creative ENGINEERING

Wellman designs and builds machinery for big and unusual handling jobs. In almost every country in the world, you will find Wellman installations. Many of them are serving the metal industry in material handling from ore mine to finished product.



MATERIAL HANDLING EQUIPMENT

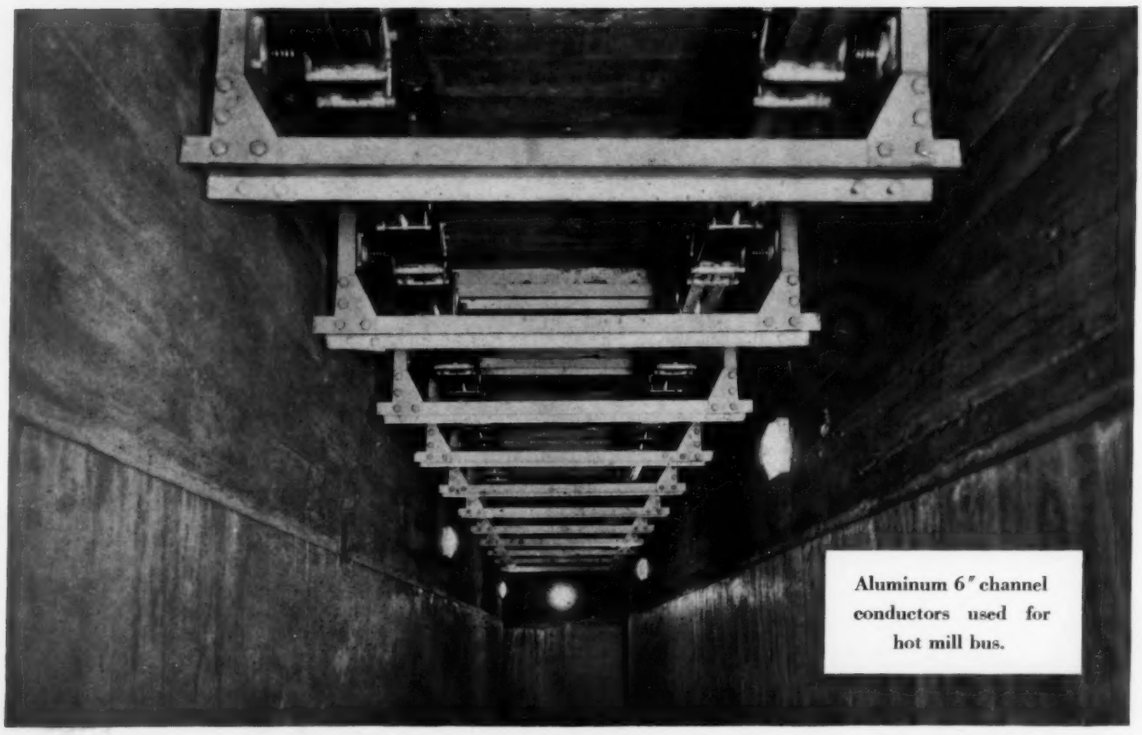
WELLMAN PRODUCTS INCLUDE: Steel Mill Equipment . . . Charging Machines, Cars and Boxes . . . Open Hearth Furnaces . . . Manipulators . . . Coal and Ore Handling Machinery . . . Clam Shell Buckets . . . Car Dumpers, all types . . . Blast Furnace Skip Hoists . . . Gas Producers, Valves and Flue Systems . . . Wellman-Galusha Clean Gas Generators . . . Gas Reversing Valves . . . Mining Machinery . . . Safety Stops for Traveling Structures . . . Welded Steel Construction . . . Castings and Machine Work to customers' drawings.

The WELLMAN Engineering Co.

ENGINEERS · CONSTRUCTORS · MANUFACTURERS

CLEVELAND, OHIO.

Inherent Economy IN FORM, MATERIAL



Aluminum 6″ channel conductors used for hot mill bus.

Channeluminum is made specifically to reduce the cost of conducting *heavy* currents. Its [ ] cross section gives the highest practical combination of electrical efficiency, ability to dissipate heat rapidly and great mechanical strength to withstand heavy, short-circuit stresses.

You can get this rolled channel conductor in lengths up to 90 feet. Inherent lightness and strength allow economical disposition of supports. Simple, inexpensive fittings are standard, and joints are easily made by welding or bolting. On properly installed runs the natural resistance to corrosion of Alcoa Aluminum is ample protection against sulphur-laden atmospheres and similar corrosive influences.

ALUMINUM COMPANY OF AMERICA, 2128 Gulf Building, Pittsburgh, Pennsylvania.

ALCOA · ALUMINUM

Why a Carborundum Company RECUPERATOR?

THERE are six good reasons, reasons based on the experience of many great industries where The Carborundum Company recuperators are functioning with highest efficiency.

1. The heat transfer elements or tubes of "Carbofrax", the Carborundum Brand Silicon Carbide Refractory.

2. The originally conceived and designed corebusters.

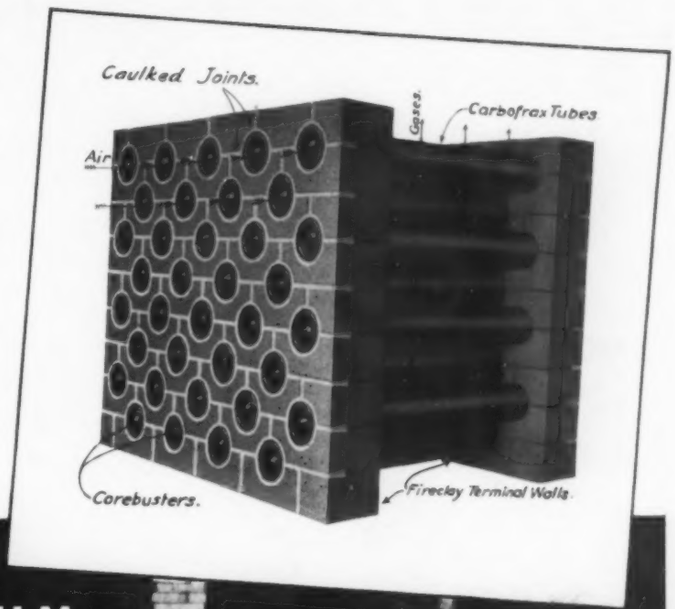
3. The accessibility of the recuperator for examinations, repairs and quick, inexpensive replacement of the tubes.

4. Minimum amount of air leakage.

5. The low first cost of installation.

6. The adaptability of the design of this recuperator to either existing or new furnaces.

Complete information regarding The Carborundum Company recuperators (engineering bulletins etc.) upon application.



THE CARBORUNDUM COMPANY, REFRACTORY DIVISION, PERTH AMBOY, N. J.

District Sales Branches: Boston, Chicago, Cleveland, Detroit, Philadelphia, Pittsburgh. Agents: McConnell Sales and Engineering Corp., Birmingham, Ala.; Calvin M. Christy, St. Louis; Harrison & Company, Salt Lake City, Utah; Pacific Abrasive Supply Co., Los Angeles, San Francisco, Seattle; Denver Fireclay Co., El Paso, Texas.

(Carborundum and Carbofrax are registered trade-marks of The Carborundum Company)

UP IN THE AIR?

MODERN Baker Fork Trucks make quick work of sheet and tin-plate handling; add substantially to storage space by higher tiering. Well fitted to handle the production of the new, high-speed mills, their sturdy construction and low maintenance write new records of lower handling costs, insure their rate of saving through many years of profitable service.

Get the facts on material handling from the Baker Materials Handling Engineer. You'll find his data accurate and helpful in considering your own handling problems. *Write the* BAKER INDUSTRIAL TRUCK DIVISION OF THE BAKER-RAULANG COMPANY, *2167 West 25th Street, Cleveland, Ohio*

OLDEST MANUFACTURER
Baker
TRADE-MARK REG. U. S. PAT. OFF.
OF ELECTRIC VEHICLES

POWER INDUSTRIAL TRUCKS FOR EVERY PURPOSE